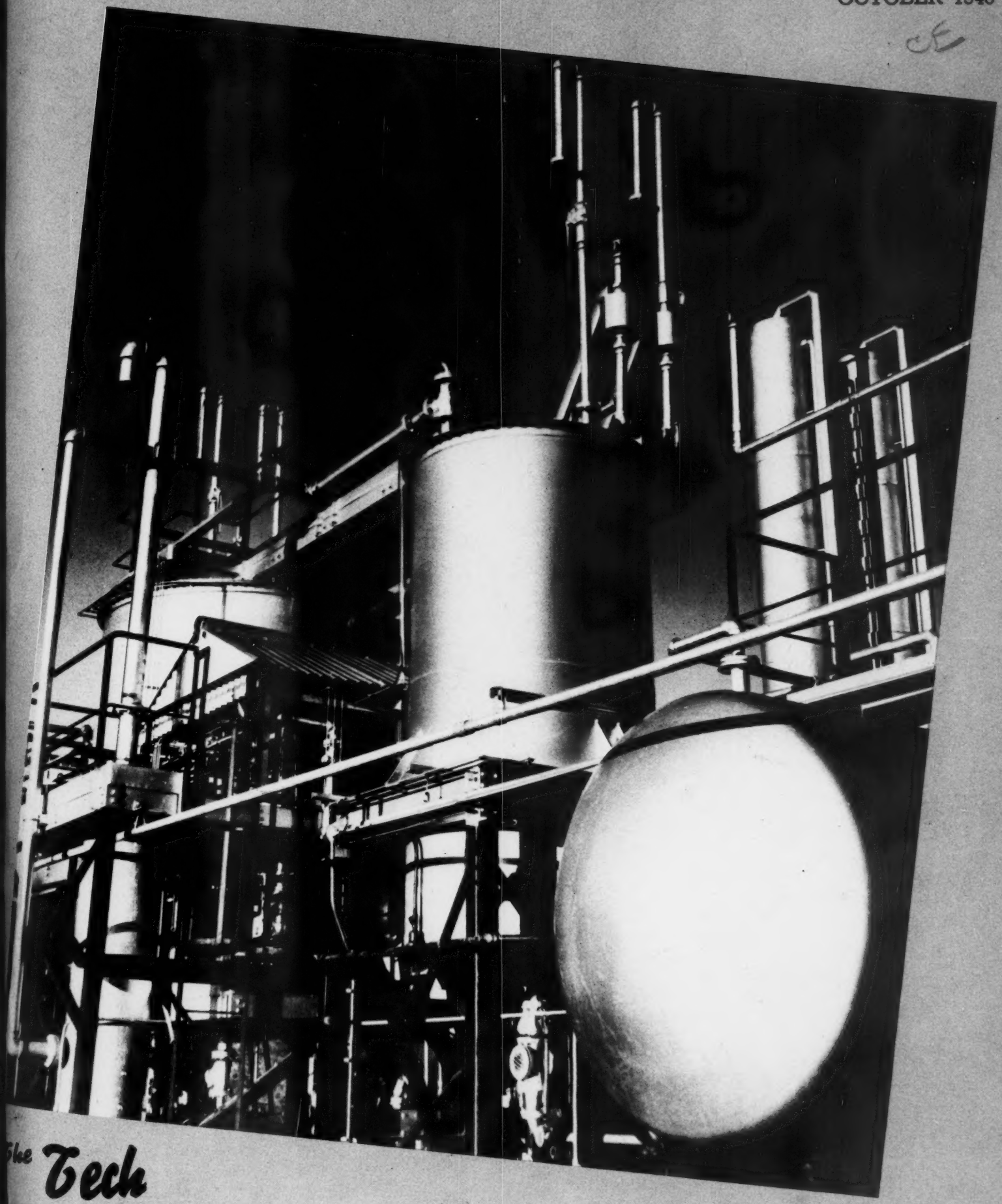
OCTOBER 1946



The Tech Engineering News

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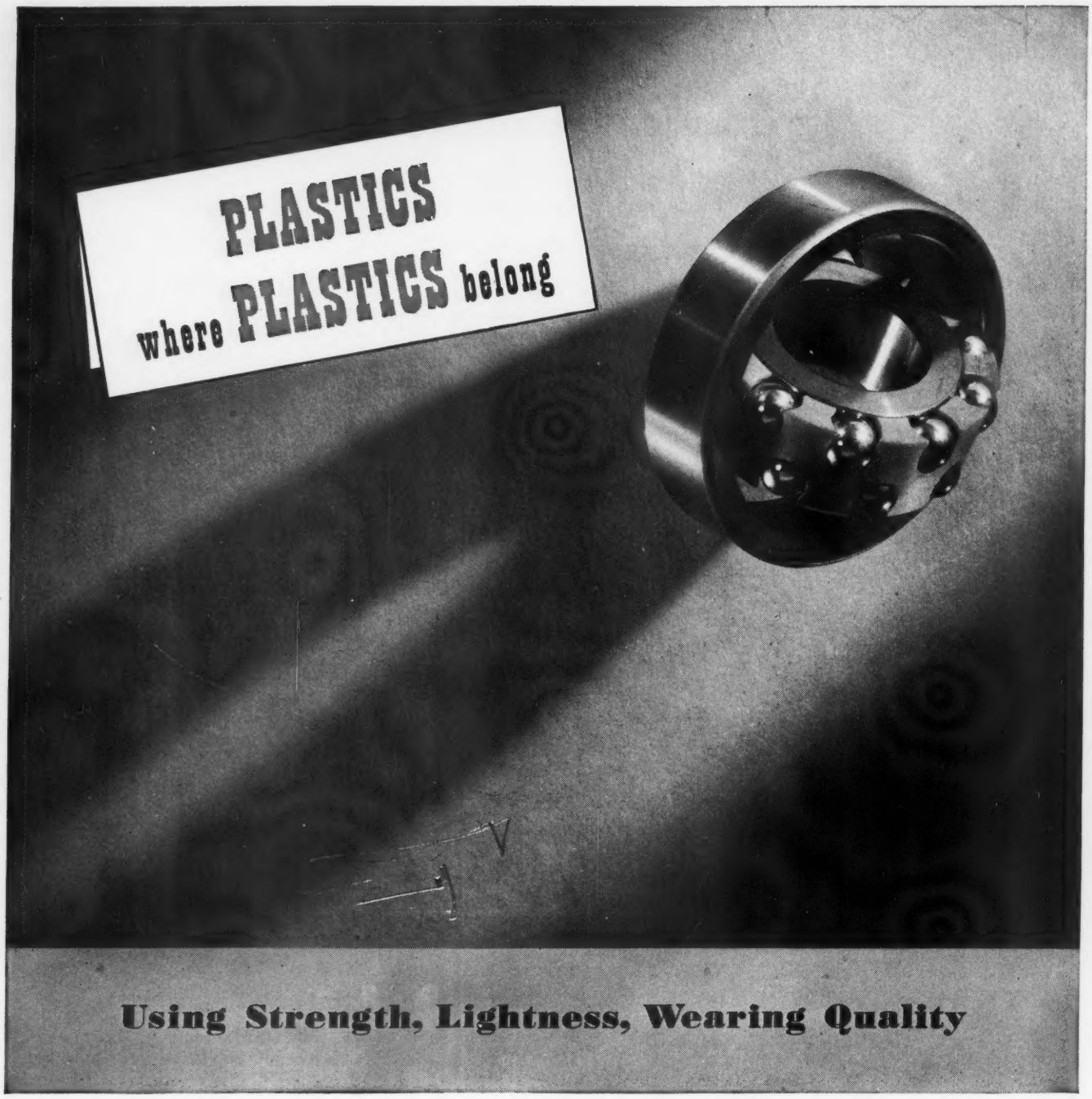

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Budd

Briefing the News . . .

Another Work-Saver for the Mathematicians . . .

Illustrations courtesy of "The Lamp"

ANOTHER machine to save countless hours of toil has been announced by the Standard Oil Company of New Jersey in its publication, *The Lamp*. A form of electrical analyzer, the new computer is used to predict the behavior of tapped oil pools.

Oil scientists have found that the problem of getting the maximum yield of oil from natural underground reservoirs where it is found is one of simply maintaining the internal pressure of the oil pool. This pressure comes partially from the oil itself, as well as from the water and natural gas found mixed in the surrounding sand of the pool. It is possible by means of involved, high-powered mathematics to compute the optimum rate of oil withdrawal, that is, the rate of withdrawal that will maintain the greatest pressure for the longest time. These two results determine the ultimate yield of the pool. Since water — and even gas — is sometimes injected into the pool to help keep up the pressure, the calculation of the best injection and withdrawal rates becomes somewhat involved. Expert mathematicians, working for a considerable time, were usually required to solve the resulting equations, while occasionally a totally insoluble problem turned up. It was to avoid these difficulties that the new machine was developed.

The principles upon which the analyzer operates are not new. In 1822 it was discovered that problems of heat flow could be handled by means of diffusion equations. About a hundred years later researchers found that the flow of liquids could be handled in the same manner. All that was needed then was the discovery that electricity flowed through networks of resistors and condensors in such a manner as to be mathematically comparable to the flow of heat or liquids. Engineers at Columbia University merged several of these principles and built an electrical analyzer that would study and compute the flow of heat.

In the meantime, out in the laboratories of the Carter Oil Company in Tulsa, Oklahoma, a thirty-one-year-old physicist, Dr. William A. Bruce, was working on the problem of the prediction of oil pool behavior. On receiving the news of the success of the Columbia machine he decided that, since this device had been used to study heat flow electrically and since heat and liquids could be described in their flow by the same equations, he should be able to construct a somewhat similar machine to solve simultaneously the problems of oil and water flow in pools.

Dr. Bruce's machine grew in much the same manner that all such devices grow. It started out as a maze of informally assembled gadgets that was constantly being improved upon. But this rough model proved that further experimentation was worth while and three consecutive, improved models were built over the years.

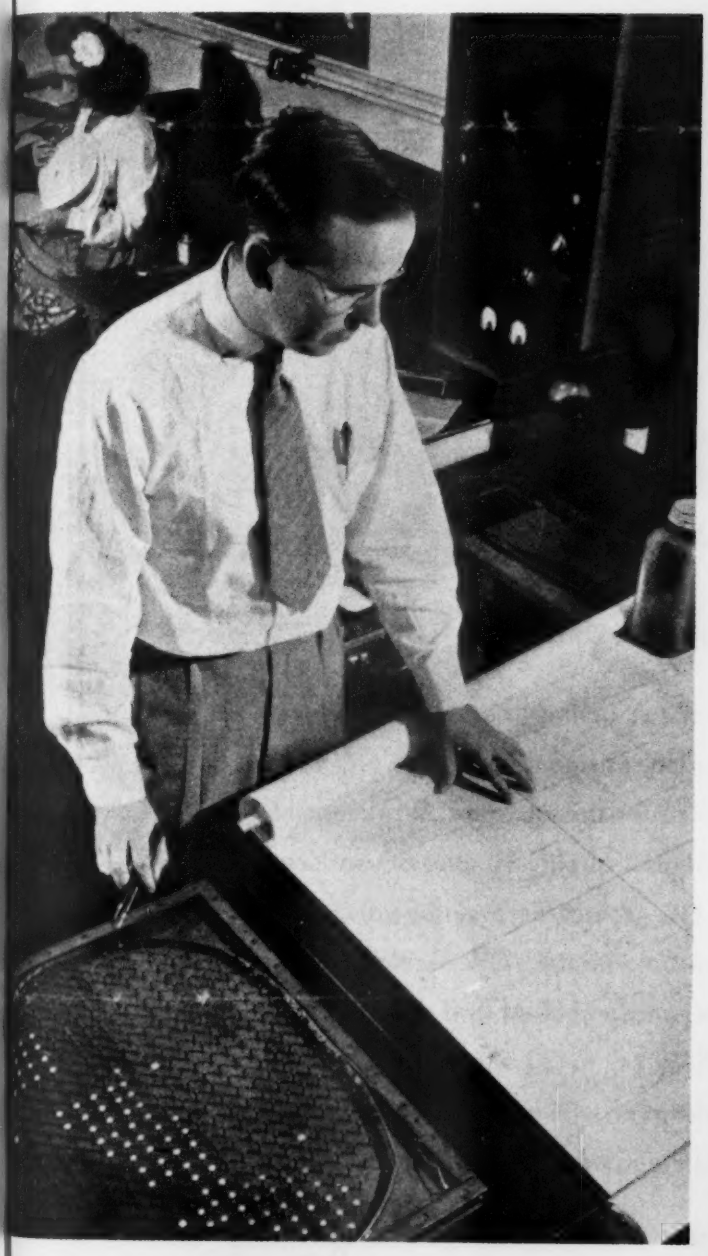
The present analyzer works somewhat in the following manner. Data, collected by field engineers at the site of a relatively new pool, is compiled and sent into the laboratories for computation. The specific information needed is: the number of wells in use, their production rates, over-all pressure history of the field from the start of operations, the amount of fluids withdrawn, and an estimate of the amount of water to be injected to help maintain pressure. From all this, one of two things can be computed. Either the rate of oil withdrawal together with accompanying injection rates needed to maintain a working pressure or the reservoir pressures at any particular rate of withdrawal can be predicted. Since the machine must have evidence from which to work, it is obvious that the more accurate and dependable the original data, the more accurate will be the predictions. Thus the best use for the analyzer is in predicting pool behavior in fields where reasonable production has already been extracted.

In the analyzer, the oil field itself is represented by a peculiar set-up, resembling to a large degree a field of oil derricks and wells. Electrodes connected in groups underneath a small table protrude through the top of the table to represent the wells themselves. Each operating well has a round tab fastened on top while injection wells are given square tabs. The sand in the actual pool is represented in the model by a glycerine-water solution that conducts and resists electricity among the electrodes in much the same manner that the sand conducts oil and water. The glycerine pool covers the first half inch of the part of the electrodes protruding above the table top.

The ability of sand to store fluids is taken into allowance by a large bank of condensers which store electricity in a remarkably similar manner. Flow from this storage point to the wells is paralleled by the use of resistors which resist current flow as sand resists liquid flow. The question of time is controlled by a device that looks much like a telephone switchboard. Here cables plug in to register past or proposed production rates, while connected relays tick off the two-and-a-half-second intervals that represent a month in the calculations of the machine.

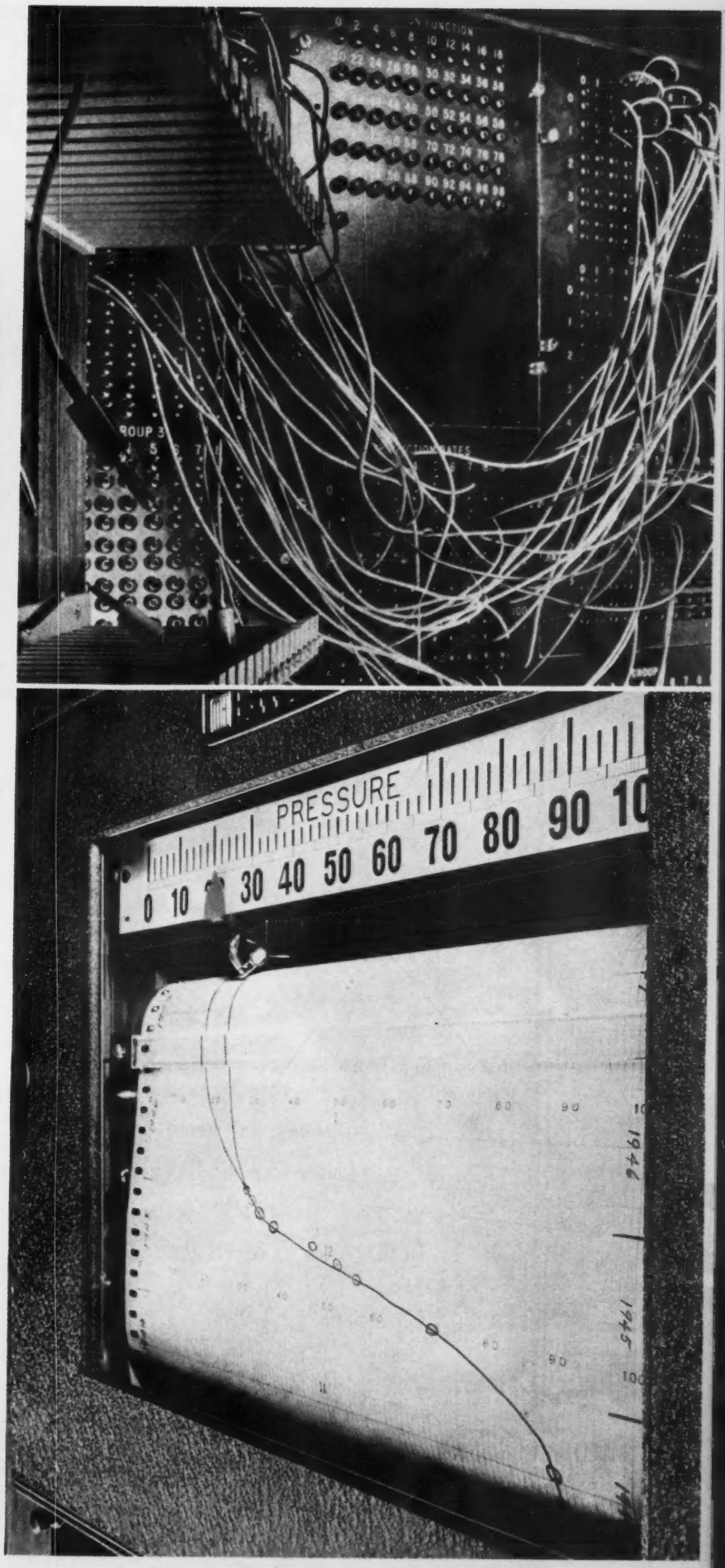
At this point, the analyzer is ready to go. Electronic tubes control the withdrawal of current from the condensers and

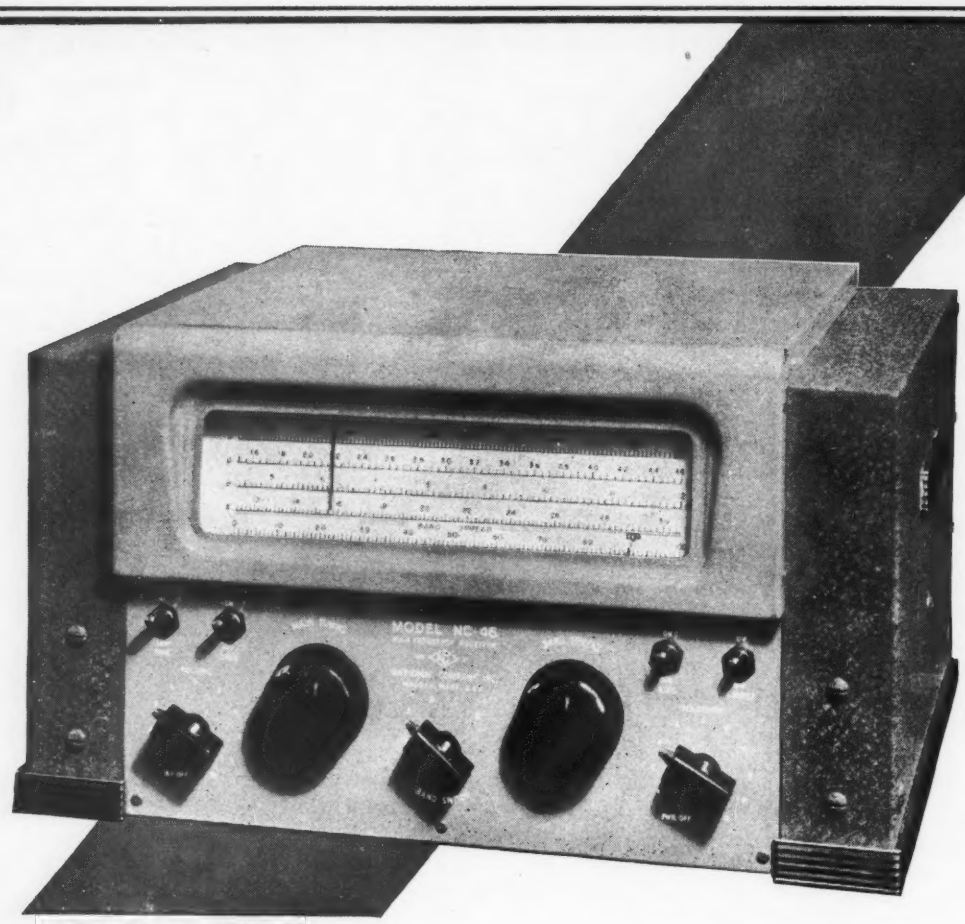
the current fed into the various resistor networks. Current is also fed into the condensers to represent the injection of water into the pool. Measurement of the voltage and amperage gives the key to the flow and pressure being represented. Final results are graphed on a chart. In the picture printed here, the single line is the field's past history while the double line represents the machine's predictions of pressure at two different rates of production. The line which promises the greatest ultimate yield will, in all probability, be the one followed.



In five minutes, the analyzer can work out a pool's future history for ten years. Experimental tests with data from old fields have given interesting results. Early data fed into the machine have produced "predictions" which match the later data on record for the same field. Recently it has done as much and more in actual work with new fields currently being developed.

While it is not a startling invention, the analyzer does promise to remove much of the drudgery from the oil engineers' life. It could also be used by universities for the training of oil engineers or by state commissions interested in conservation.





NC-46

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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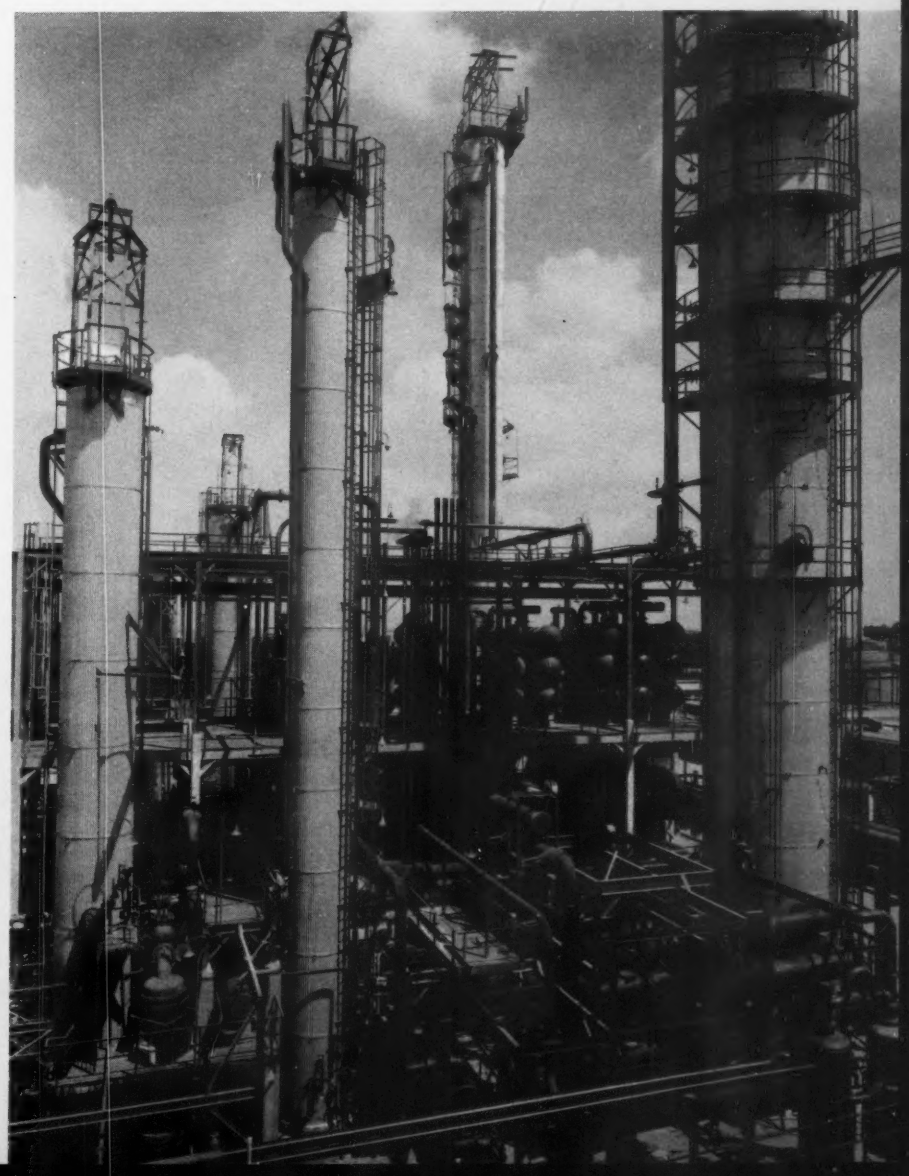

COVER

A seeming maze of efficient piping, typical of today's chemical industry.

TITLE PAGE

Alkylation unit of the Texas Company, Port Arthur, Texas

The Texas Company

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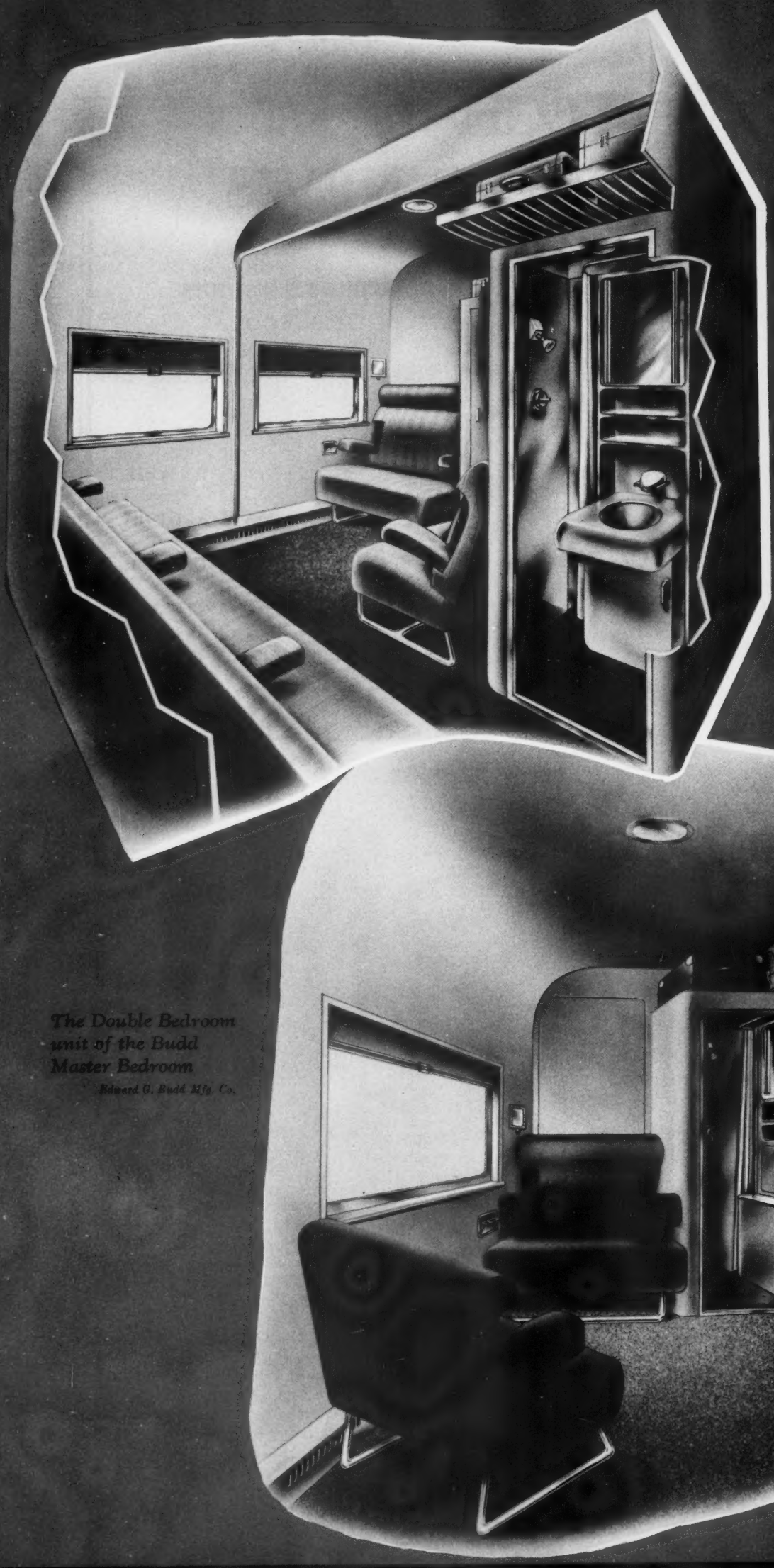


Budd's Master Bedroom
Edward G. Budd Mfg. Co.

The Double Bedroom unit of the Budd Master Bedroom
Edward G. Budd Mfg. Co.

New Comfort on the Rails

By JOHN W. WEIL, '48

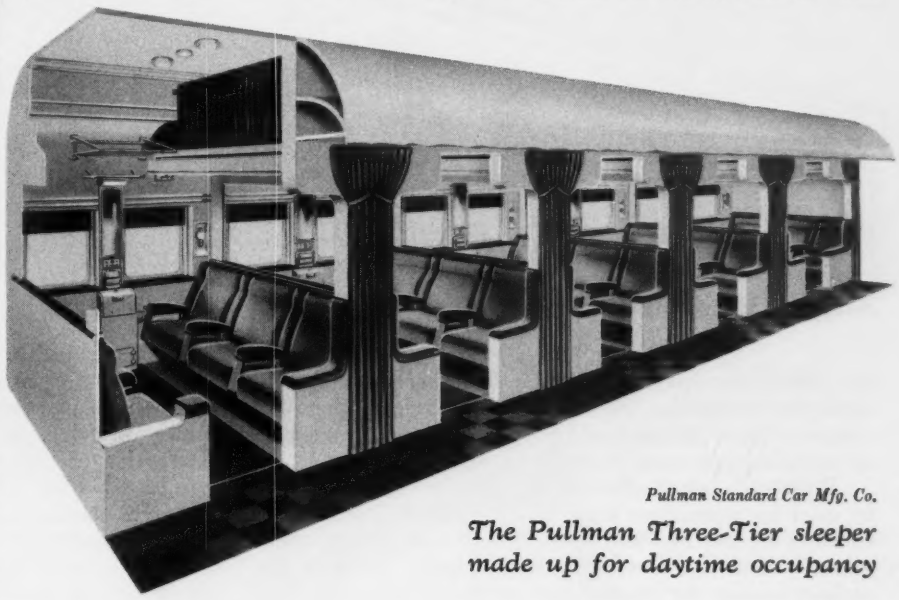
FOR nearly a century the American railroad system has been the nation's principal artery of passenger travel. With greatly increasing competition from the airlines and with a constant level of competition from bus lines, the various rail networks face a postwar problem whose outcome may well determine the immediate fate of passenger train service throughout the nation.

The railroad's greatest advantage over the other two major modes of passenger transport is its large amount of available space without regard to weight or balance. This space can be made use of to provide privacy, recreation, and a degree of luxury that, so far, is impossible on either a bus or a plane. This space, however, must be available to the traveler at the lowest possible price. Economy can be obtained in many ways. One of the easiest is to carry more people per trainload — since weight is a relatively unimportant factor. And it is thus that the design engineer is confronted with the seemingly irreconcilable factors of economy of space and completeness of luxury and service.

In the prewar period, new kinds of accommodations had begun to replace the traditional Pullman car with its upper and lower berths. Cars consisting solely of double bedrooms, Roomettes, or other like arrangements had appeared on almost all of the major railroads, while combination cars with a variety of set-ups were becoming increasingly popular. With all indications predicting an extremely active era of travel in the next several years, the railroads are eagerly investigating possibilities for new kinds of car arrangements and accommodations — ones that will make for greater passenger comfort and more economical usage of space.

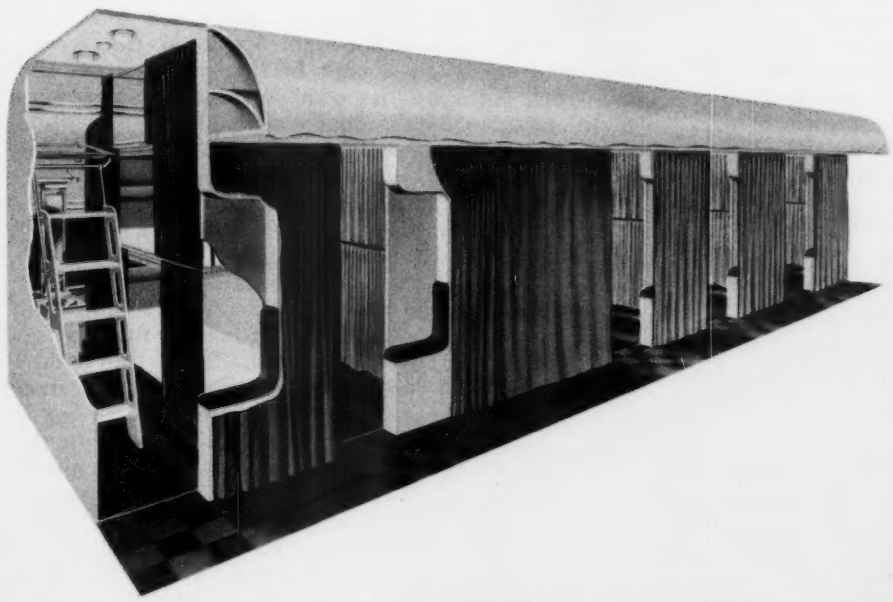
Probably the first new cars to make their appearance on the rails will be the new coaches. Because of the terrific beating taken by the older models during the rush war period, there is a great demand for replacements along this line. Since this new equipment must thus be bought for reasons of necessity, many railroads are making the most of the expenditure by buying new and more up-to-date coaches at the same time.

Three new types of coaches are being offered. The



Pullman Standard Car Mfg. Co.

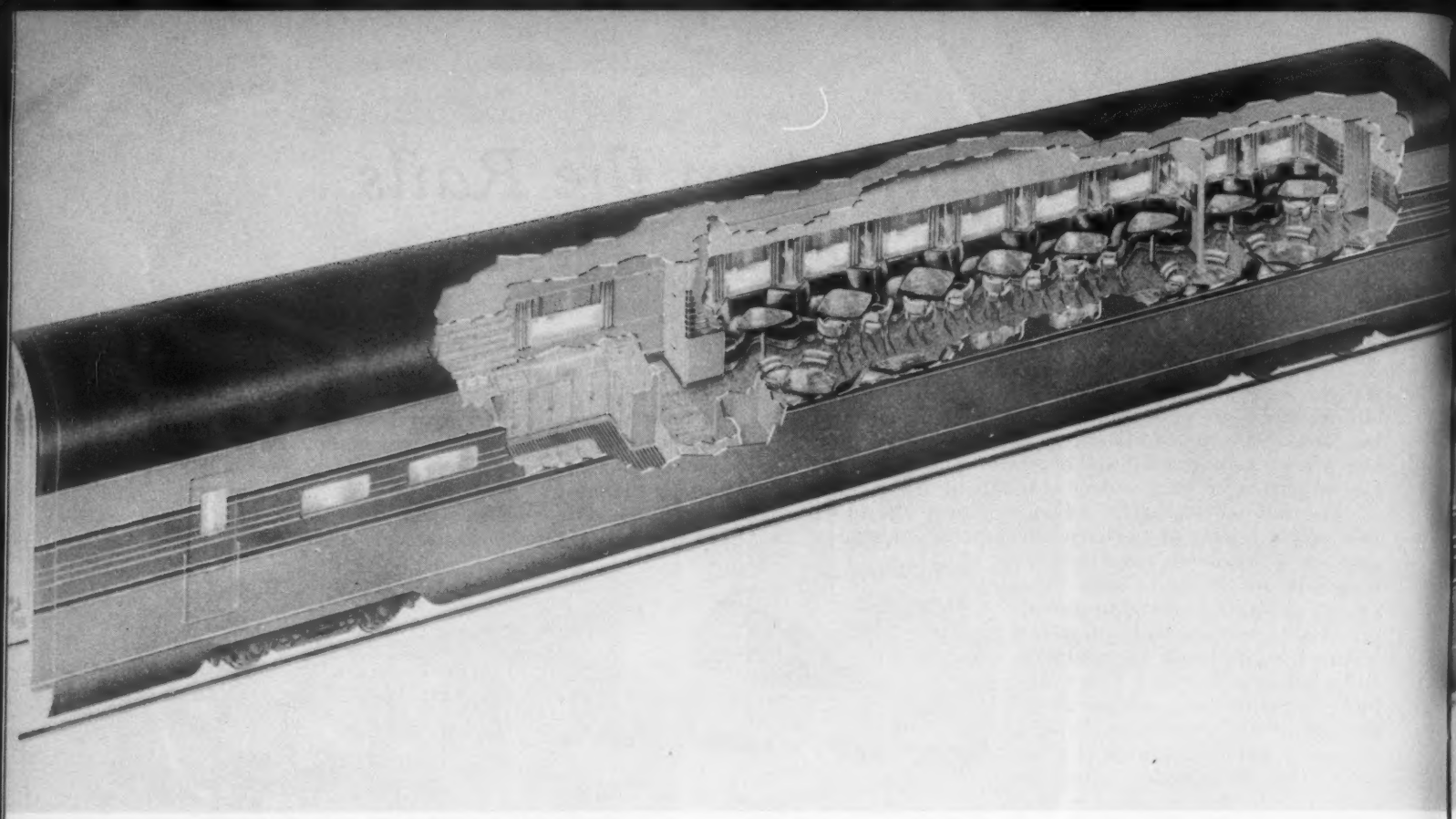
The Pullman Three-Tier sleeper made up for daytime occupancy



The Three-Tier car ready for night use

E. G. Budd Manufacturing Company, one of the country's major car builders, has designed a coach with a couple of interesting innovations. Each seat has not only an adjustable back, but also an adjustable, built-in foot and leg rest. The seat was designed to provide the maximum in relaxation in both the upright and reclining positions. Furthermore, each seat has its own four-channel radio, complete with ear level speaker and automatic volume control, adjusted so that the radio's use will not disturb the occupants of adjoining seats.

The Pullman Standard Company is offering two unique kinds of coaches. The first, the Day-Nite coach, designed for long distance operation, has forty-eight reclining-back seats arranged in pairs along the car in the usual manner. Each seat has its own focalized reading lamp and draw-curtains while, concealed in the back of every chair, there is a folding leg rest for



A typical diagonal diner of the future

Pullman Standard Mfg. Co.

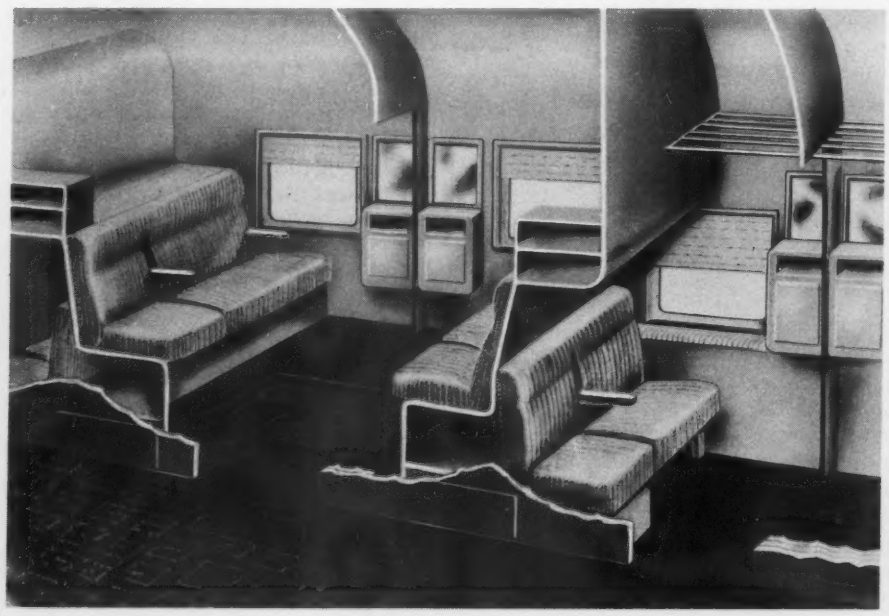
the person occupying the chair to the rear. Each of these new coach cars will include six individual dressing rooms — three for men and three for women — as well as extra baggage storage space in the roof.

Pullman's other offering, the Threedex coach, is to be used for commuter work where extreme luxury and comfort are not necessary, but where economy of operation is vital to allow low-priced tickets. Built at the regular height, the ends of this unusual car are used to provide dressing rooms and four semi-private game sections to be used at the discretion of the passengers. The center of the coach has two decks — one lower and one higher than the ends of the car — each containing seats. In the lower level, the seats face outward in a row down the center of the car, while the upper level seats are arranged in the more conventional style of pairs of seats in rows, facing forward. This strange set-up allows greater room per passenger and, at the same time, better use of available space for the railroad because of the larger capacity of the car.

In a bid for the market that will exist for low price sleeping accommodations, a railroad may adopt the new Pullman Three-Tier sleeper. With compartments for three or six people, the car — when arranged for daytime travel — has cross-train seats with individual armrests, soft cushions, luggage space, and wide windows. When made up for night operation, the sleeper contains rows of three-high berths, going across the car. Each berth has its own curtains, complete air-conditioning, and individually controlled lights, while each compartment has lavatory facilities. At the ends of the car are two individual washrooms and a toilet.

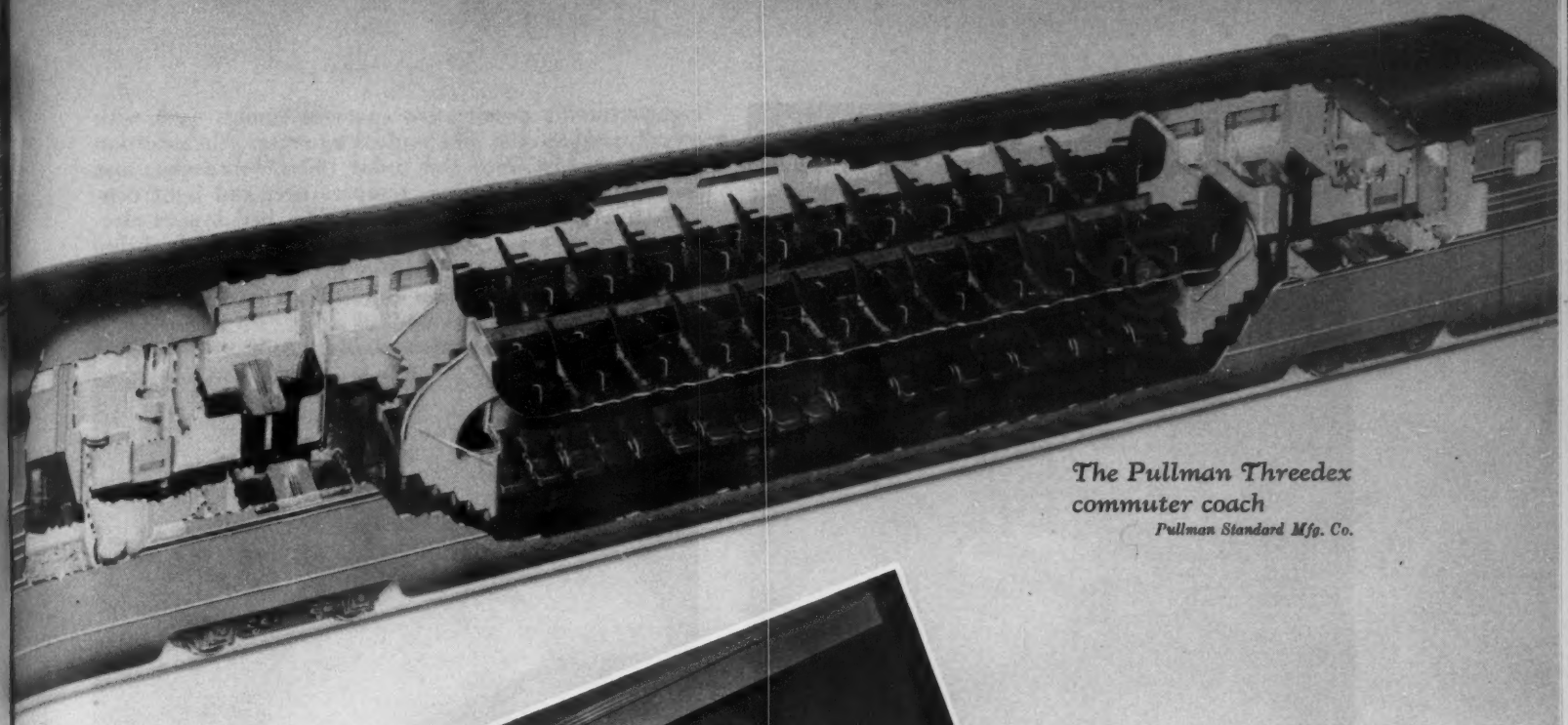
The Budgette as proposed for daytime use

Edward G. Budd Mfg. Co.



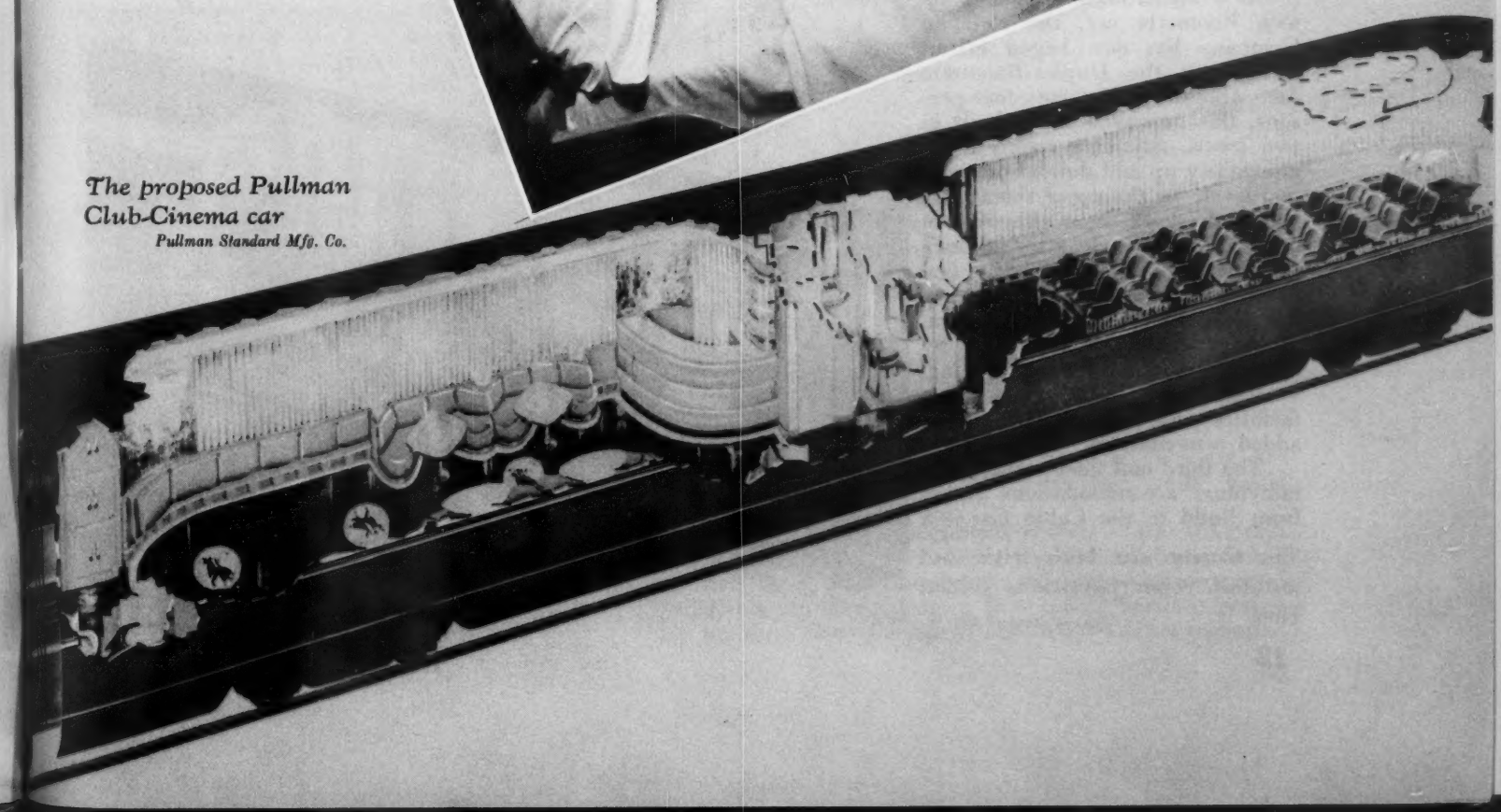
Already in experimental service, these revolutionary cars each contains accommodations for forty-two persons. From the engineering point of view, it is interesting to note that while the upper berth is more or less permanently installed, the middle berth folds directly upward against the bottom of the high berth and is secured in place by folding up the partition that shuts off the ends of the berths from the aisle. The lower berth is made up in much the same manner as the lower berth of the regular Pullman car — the armrests folding flush into the seats.

While the prewar Roomette cars were immensely popular with the passengers, the fact that each car would only hold eighteen of these compartments was a constant reminder of the fact that economy had been sacrificed for the sake of luxury. Budd's new Budgette, one of the many new offerings designed to



The Pullman Threedex commuter coach
Pullman Standard Mfg. Co.

A lower-tier Pullman Duplex-Roomette with bed pulled out



The proposed Pullman Club-Cinema car
Pullman Standard Mfg. Co.

Pullman Standard Mfg. Co.

The Duplex-Roomette with the bed concealed

replace or complement the Roomette, has individual rooms for thirty-two persons per car. In order to effect this the rooms are arranged in two levels, alternately in pairs, both rooms opening out into the car's main aisle. Adjacent rooms on the same level can be thrown together to form a two-person suite. Beds in the Budgette apparently run across the car — each bed being pre-made and stowable by either the passenger or the porter. Besides the bed each room contains its own toilet, wash basin, cabinet, carafe, and mirrors. The fact that so many of these compartments can be built into a single car means that the cost of occupancy per traveler will be slight indeed.

As a modernized version of its own Roomette car, the Pullman Company has now begun manufacture on the Duplex-Roomette car. Able to carry twenty-four persons, this improved car is built in two levels, adjoining rooms being alternately up and down from normal level. In the upper rooms, the bed folds down from the wall to occupy a position lengthwise along the side of the room while the bed in the lower compartment slides out from under the adjoining high room. Passenger comfort is insured by personal control of heat, lighting, ventilation, and so on, with washing facilities and concealed toilet as added conveniences.

The third and final proposal for individual accommodations comes from Budd in the Cabin Car — a car containing twenty-two spacious rooms, each with an adjustable seat and stuffed armrests. In addition each room provides the usual toilet, wardrobe, and mirrors; air-conditioning, temperature, and light controls plus a case for valuables. The bed lowers electrically from a vertical position on one wall. Lighting is unusually complete with fluorescent lights being used for the main illumination — supplemented by a spot-

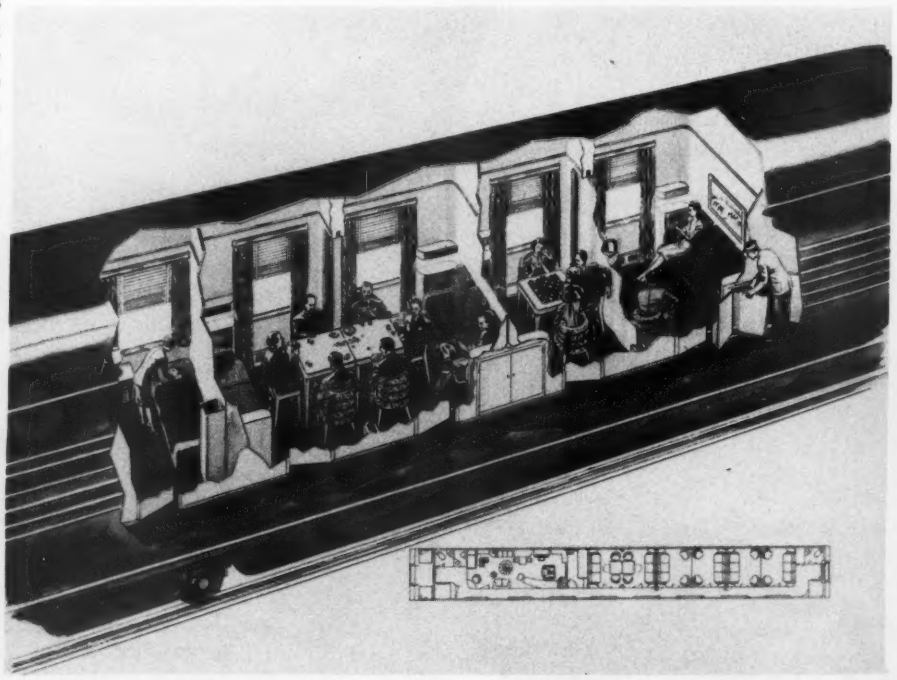
A mock-up of a table in a typical diagonal diner

Pullman Standard Mfg. Co.

light for reading. These rooms are built all on one level and are Budd's bid for competition with the Pullman Roomette — an accommodation of approximately the same order.

Along the line of more elaborate accommodations, Pullman offers three basic types of compartments. The first, the double bedroom, sleeps two persons, one bed being made out of the cross-car seat, and the other folding down from the wall to form a type of upper berth over the lower bed. When it is desired, the partition between adjoining double bedrooms may be opened to form a four-person room. The second, the compartment, is a two-person living room when set up for day occupancy. It contains — as does the double bedroom — complete toilet facilities and all the other

(*Continued on page 46*)



The Casino car both with and without room partitions folded back

Pullman Standard Mfg. Co.

Micro-Pulse Radio-Telegraphy

By *FRANCIS A. GIORI, '45*

All illustrations are staff drawings

LONGER life? Less juice is the answer. By using less electricity to perform the same task as before, it is possible to lengthen the life of dry cells, and eventually of portable radio equipment as well.

Given a situation such as the one which the Chinese Army recently faced, with hundreds of miles of frontier held for miles only by isolated villages and guerilla bands equipped with often inadequate means of communication, the doubling of the life of the meager supply of transmitting equipment supplied them would have proved helpful indeed.

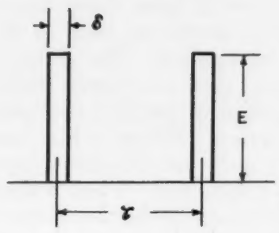


Fig. 1

The problem in design was the necessity to develop a system whereby Morse code characters could be transmitted, not as pulses of about one-tenth of a second in duration, but as pulses of about one ten-thousandth of a second. Such pulses would not change the timing ratio between the Morse characters. With short pulses the duty cycle of a transmitter would be quite low, and a very large peak power could be obtained without excessive drain on the plate supply and without exceeding the plate dissipation of the output tubes.

The first investigation was necessarily an examination of just how short the pulse could be without introducing difficulties from tubes and other units. It was desirable to make the pulse as short as possible, since the shorter the pulse, the smaller the value of the average current. Pulses were then investigated to determine just how short they could be without exceeding a reasonable bandwidth of ten thousand cycles at the transmitter, that is, a top frequency limit of five thousand cycles.

Examination of short, rectangular pulses, as shown in Figure 1, gives

$$a_k = \frac{\omega}{2\pi}\int_{-\pi/\omega}^{\pi/\omega} \left(f(t)\,\epsilon^{-jk\omega t}\right)dt$$

and in this case

$$a_k = \frac{\omega E}{2\pi}\int_{\frac{\delta}{2}}^{\delta/2} \left(\epsilon^{-jk\omega t}\right)dt$$

$$= \frac{\omega E}{2\pi}\left[\frac{\epsilon^{jk\omega\delta/2} - \epsilon^{-jk\omega\delta/2}}{j^{k\omega}}\right]$$

whence the exponential evaluates to this value

$$\frac{\sin k\omega\,\delta/2}{k\omega\,\delta/2}$$

and

$$a_k = \frac{E\delta}{\tau}\,\frac{\sin k\omega\,\delta/2}{k\omega\,\delta/2}$$

It may be noticed that the envelope (see Figure 2) for the lines in the amplitude does not change with different ratios of δ/τ, but that the spacing of the lines does change and is determined by the time between the pulses. This means that making the pulse shorter increases the high frequency range required, while increasing the pulse spacing makes the lower frequency range required broader. It is difficult to tell from the amplitude spectrum how many of the harmonics must be transmitted in order to obtain a well-shaped pulse; certainly, if all the frequencies in the first hump of the amplitude spectrum were retained, the wave shape would be excellent. However, pulse quality of this degree is not necessary, and it is not desirable to have a perfectly flat pass band and infinite attenuation beyond that in practical filters and so forth.

Having arbitrarily limited the top frequency to be transmitted at five thousand cycles, a pulse with an upper half power point of five thousand cycles was passed through an amplifier.

After a time equal to $1/RC$ (see Figure 3) the voltage had increased to within $1/\epsilon$ of its final value, or about 2/3 of the final voltage. After a time $2/RC$ had elapsed, the voltage across the condenser had reached close enough to the final value to satisfy the arbitrary requirements. Allowing one more $1/RC$ period for a quality safety margin, it became evident from this rough analysis that a pulse of about one ten-thousandth was the shortest practical pulse. Using a 10^{-4} second pulse for the "dot" pulse, the "dash" would then be about 3×10^{-4}.

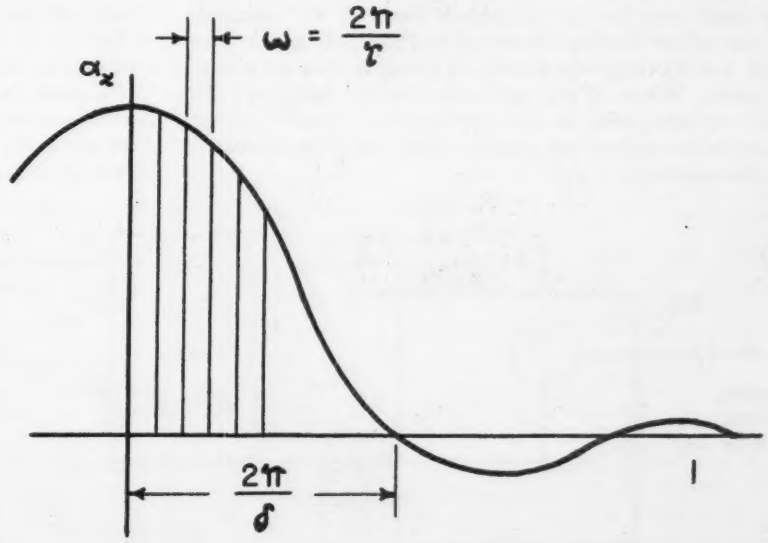


Fig. 2

A transmitting handbook reveals at this time that a dot has a duration of about one-tenth of a second, a dash three times that length; that spaces between characters are of dot length; that spaces between groups are three times dot length; and that words are separated

by an equivalent time of six dots. From this data, it would appear that pulses will be spaced about .1–.05 seconds apart. At a spacing of .05 seconds the transmission rate would be better than sixty words per minute, which is very fast. In ordinary transmission about twenty-five words per minute is considered good; and in military messages, where code is used, speeds of about twelve words per minute are obtained.

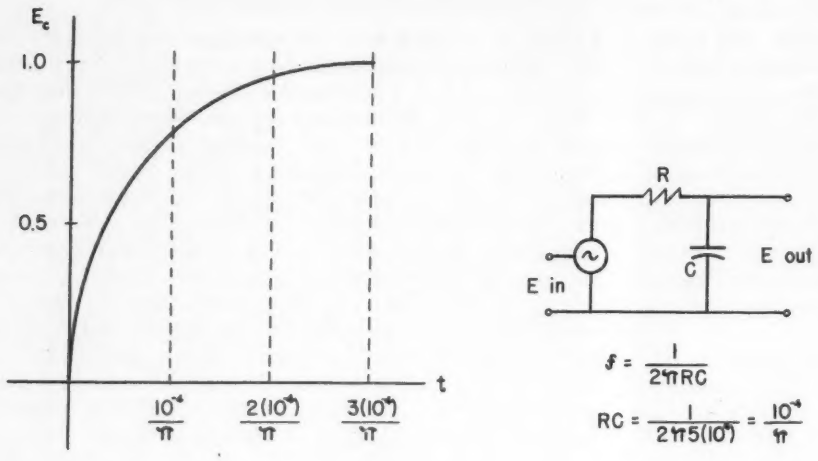
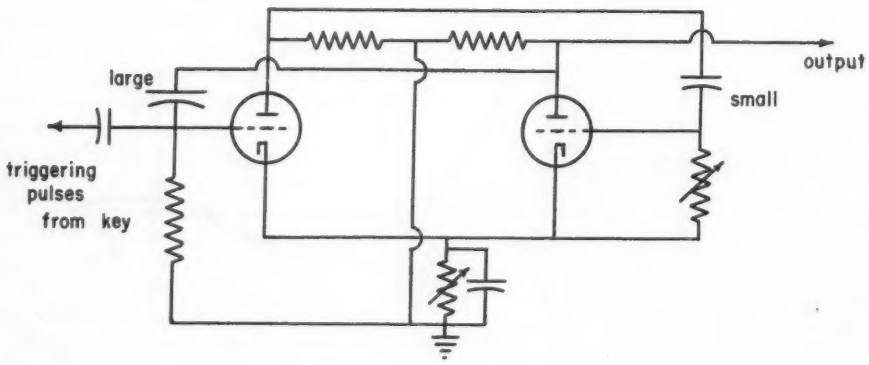


Fig. 3

Even in the limiting case where only dashes are sent at a speed equivalent to sixty words per minute, when using 10^{-4} pulses, the ratio of peak to average power is better than 100 to 1; and in ordinary message transmission the ratio is more nearly 500 to 1.

To generate these short pulses, two flyback circuits were used, one having a flyback time of 10^{-4} seconds and the other having three times that period. A telegraph key having two positions (similar to a bug key) was used. When in one position the key triggered the "dot" circuit, and in the other the "dash" circuit. These pulses were then amplified and used to modulate the transmitter.



PULSE FORMING CIRCUIT

Fig. 4

At the receiver the output from the detector tube was short pulses as those sent by the transmitter. In order to distinguish between dots and dashes, the pulses were integrated. The integrated pulse was amplified and used to trigger two more flyback circuits, one triggering at four volts and the other at eight. The first of these circuits responded to integrated "dot" pulses and was therefore adjusted to have a flyback time of dot length or one-tenth of a second; the second circuit responded to the higher voltage which was obtained by integrating the longer "dash" pulses, and its flyback time was made equal to standard dash or about three-tenths of a second. The output pulses obtained from these flyback circuits were applied to the third grid of a 6SA7, which was continuously excited by a 1000 cycle oscillator on its first grid. The 6SA7 was biased to the point that no output was obtained until a positive pulse from the trigger circuits was applied to its third grid, at which time there was a 1000 cycle output as long as the pulse was applied. The outputs from the two converter tubes were applied in parallel to a pair of earphones. When a dot was received only one of the trigger circuits responded. When a dash was received, both the circuits responded. When a dash was received, both the circuits responded, and the dash pulse had a large amplitude for the first one-third of its duration and an amplitude of one-half the starting amplitude for the remaining two-thirds. This effect, though accidental, was fortunate in that it gives crispness to the signals.

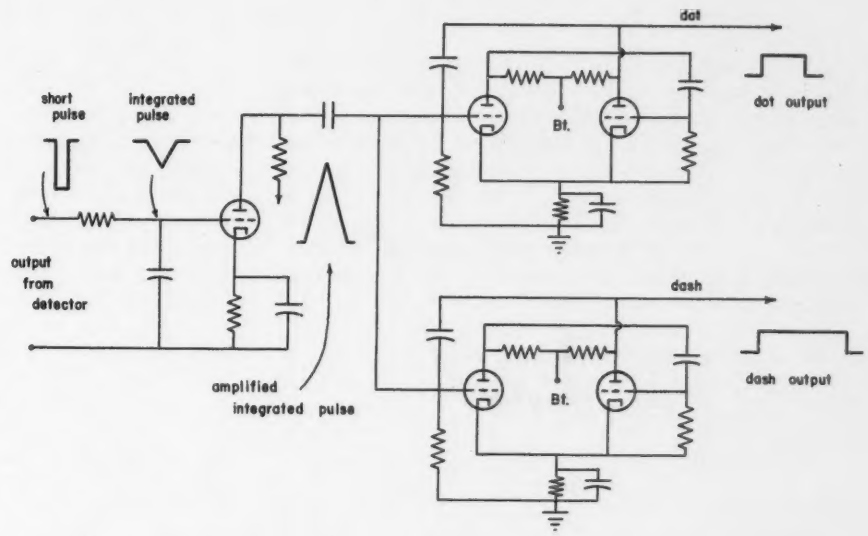
Examining the circuits in detail, the first component encountered is the pulse-forming flyback circuit. A multivibrator biased on one side below the cutoff is used as the trigger circuit. In the circuit as shown (Figure 4) the tube on the right conducts steadily, while the tube on the left is cut off in the normal case. If a positive pulse is applied to the tube on the left, it will conduct and will cut off the other tube; the tube on the right will remain non-conducting until the condenser in its grid circuit has charged and its grid has reached the cut-off voltage. When the tube on the right conducts, it shuts off the other tube, and the latter will not be able to reach conduction again because its grid is biased past cut-off in the steady state condition. The next pulse will start off the same cycle again. The output of the right-hand tube in the circuits is nearly square-topped and has a duration determined chiefly by the time constant of the resister and condensor in its grid circuit. Two of these circuits are required for a working outfit, one for the 10^{-4} pulse and the other for the 3×10^{-4} pulse. These pulses are then used to modulate the transmitter output.

The receiver is perfectly conventional as far as the detector. From the detector pulses of from 10^{-4} to 3×10^{-4} are obtained. These are integrated by means of an RC network, and then amplified to the value required to trigger the flyback circuits.

The outputs from the trigger circuits are fed into

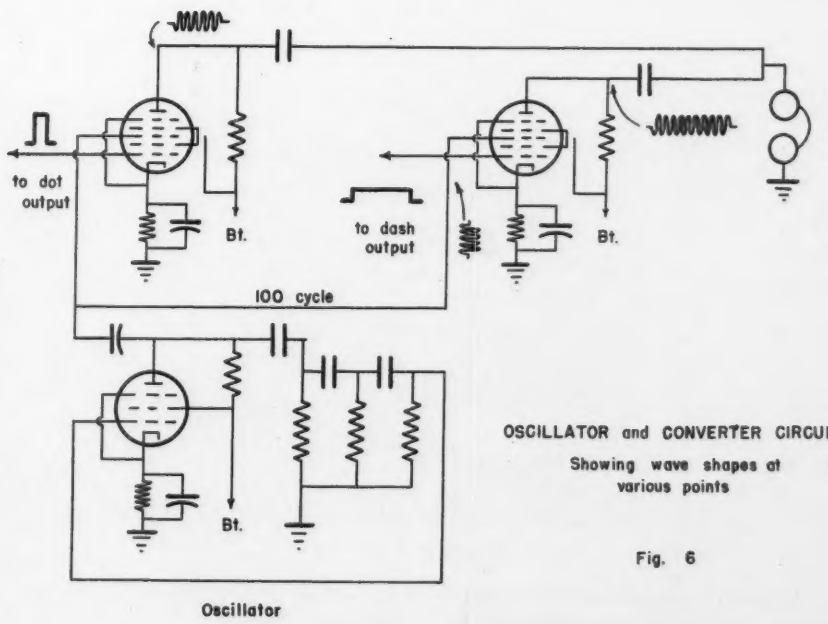
the control grids of two converter tubes (6SA7). These tubes are driven by means of a 100 cycle phase shift oscillator. The circuits and important wave shapes are shown in Figures 5 and 6.

The transmitter advantages derived from this system are considerable, but the receiver becomes quite complicated, and requires more current to operate the extra tubes. Therefore, this system represents no particular advantages at the receiver, but is quite suitable when used by field transmitters with heavier mobile receivers.



INTEGRATING and MORSE CHARACTER forming CIRCUITS

Fig. 5



OSCILLATOR and CONVERTER CIRCUITS

Showing wave shapes at various points

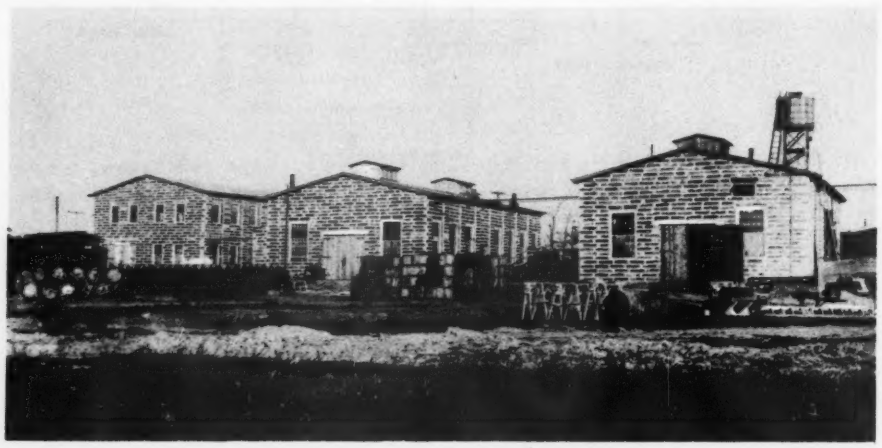
Fig. 6

An Experiment in Industry

I. A HISTORY

By EDWARD M. KOSOWER, '48

SOUTH of the small New Jersey town of Bound Brook stands the main plant of the Calco Chemical Division of the American Cyanamid Company. One hundred and thirty buildings spread over five hundred acres comprise an immense chemical manufactory, even in these days of immense plants and quantities. It is a tribute to its founders because they started the plant with about as much experience in the chemical line as a boy with a chemical set. And, as an experiment in industry, it is an unqualified success!

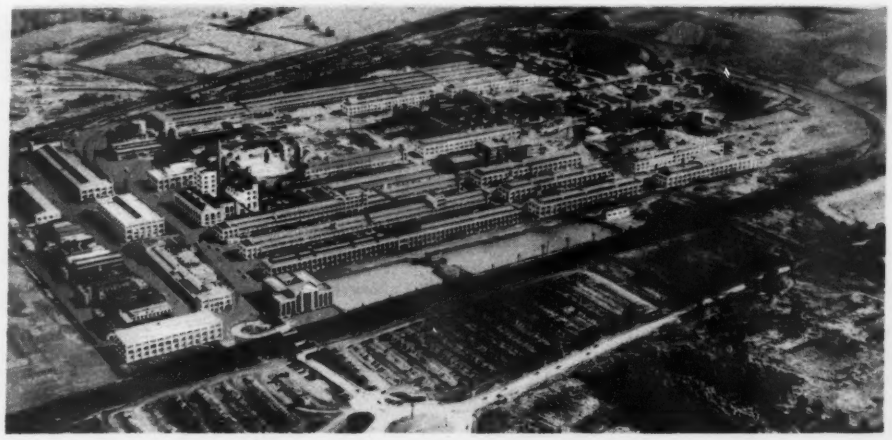


Calco in 1916; producer of aniline and beta naphthol *Calco*

In the latter part of the last century, the German chemical companies formed the famous Six Companies Dye Cartel. By gaining control of key patents and vicious big business tactics, they managed to keep American competition in the dye, chemical, and medicinal fields down to a minimum. American users of these products were forced to pay high prices for these items. This was the situation as war struck in 1914 and the British raised their blockade against Germany. At first, Germany was allowed to export these precious substances to America, but the British saw the necessity for cutting off trade to Germany on all vital materials and added chemicals to the contraband list. The last big shipment of the war was carried on the *S.S. Matanzas* from Rotterdam to New York in the winter of 1914–1915. It consisted of dyes and medicinals and was reported to have sold for over a million dollars. By the summer of 1915, chemical exports from Germany had virtually ceased and dangerous shortages in potash, coal-tar dyes, medicinals, and intermediates became apparent. In this position, American industry was forced to take steps, and the founders of Calco did.

The Cott-a-lap Company of Somerville, New Jersey (some five miles from Bound Brook), was suffering in 1915 from the shortage of beta-naphthol and dyestuffs for jute. Failing to locate any reasonable domestic source for any of their requirements, they decided to fill them by "lifting themselves up by their own bootstraps." The decision to manufacture intermediates and dyes was a hard one to make, since the company had had no experience whatsoever in these lines of manufacture and its chemical staff was well filled with one chemist. However, they were desperate and many of the directors of the venture secretly hoped that the business would be more permanent than just a wartime measure. So with the advice of a Yale professor, several assistants, and some worn copies of a few dye manufacturing handbooks, they launched a plant in Somerville.

The men were forced to start from scratch, devising and altering equipment, adjusting procedures, and providing their own methods of analysis. In view of their dye needs, the first product scheduled for production was aniline. In 1915, this important intermediate for dyes was scarce; assured production would find a steady market if they could produce more than their own needs. And, indeed, a near-by rubber manufacturer, who wanted the aniline as an accelerator, promised to take their surplus if its quality met certain minimum standards and the price was not too staggering. For similar good reasons, the directors planned a beta-naphthol plant at the same time.

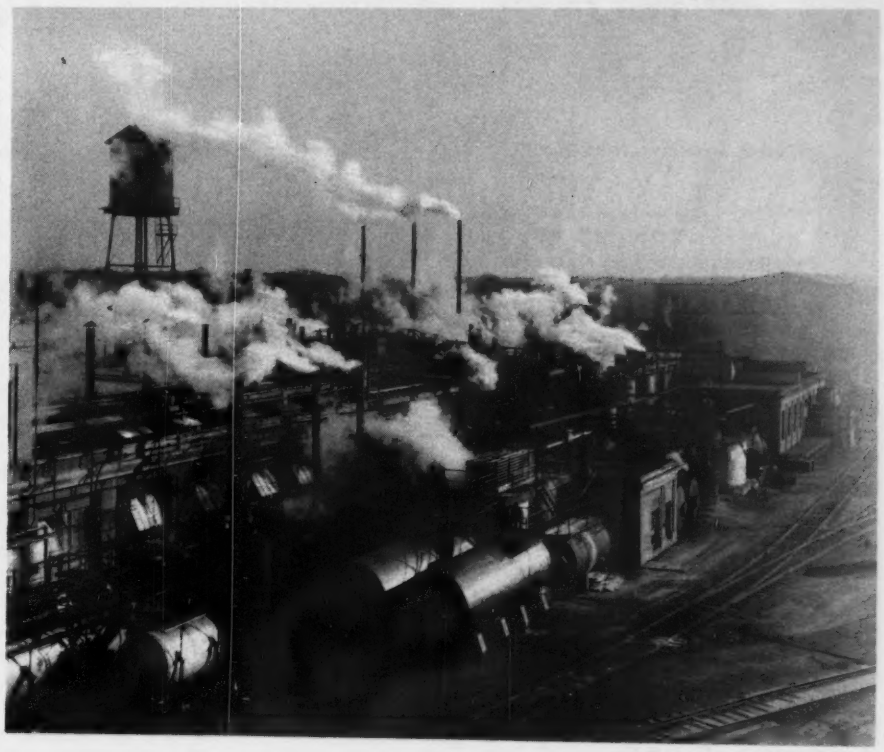


The Calco plant today *Calco*

Early in the winter of 1915, the aniline plant was completed and tested with good results, considering

lack of training of the operating personnel. Soon after, the beta-naphthol plant was also in production. As details of operation were worked out and standardized, it became possible to add more products, produced from available sources, *i.e.* aniline and beta-naphthol. Aniline hydrochloride, dimethylaniline, *R* and *G* salts were among those first added to the list. Everything seemed to be going along smoothly for the new enterprise when the City Fathers of Somerville, offended by the plant's displeasing odor, clamped down on further expansion. The ban caused the reorganization of the Calco Chemical Company as an independent organization and its removal to its present location in Bound Brook.

The choice of location in Bound Brook was an excellent one. The land was situated between the Central of New Jersey and Lehigh Valley Railroads and was bounded by a tributary of the Raritan River. The property had been purchased in early 1915, so that by the fall of the same year, it was ready to send forth its production. By the end of of 1916, after further and furious construction, Calco had produced methylene blue, crimson, scarlet, and tartrazine.



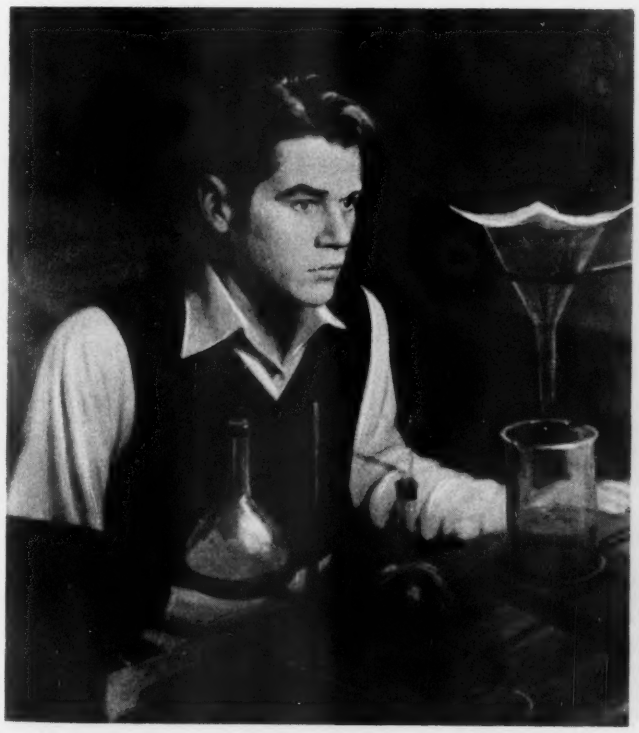
Calco

View of a section of the Aniline Oil and Beta Naphthol plant at Chicago

Much research had to be done on procedures derived from the literature as these did not give the best possible methods in most cases. For example, according to texts, the sulfonation of naphthalene should have taken eighteen hours; the chemists who were developing the process found that by juggling the pressures and temperatures used, reaction time could be shortened to seven hours. The sulfonation of naphthalene is an intermediate step in the preparation of beta-naphthol. Calco also discovered the necessity for having standardized raw materials. This was back in the days when the only methanol on the market was that distilled from wood. Calco produced dimethylaniline from methanol which almost invariably contained small amounts of acetone, of which the slightest trace produced a methane base which upset some reactions and cut down yields. However, before the chemists had ferreted out the cause of the difficulty, they sweated for days over dimethylaniline that was not being produced at the right price or in the right purity. The solution was, of course, to remove every last trace of acetone from the wood alcohol.

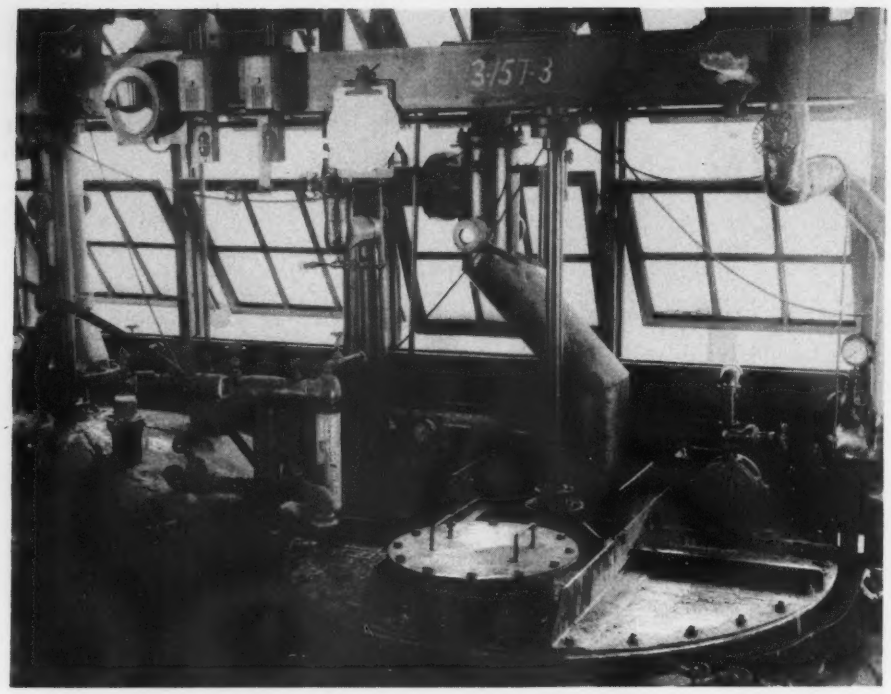
Young Sir William Henry Perkin at work. It was he who discovered the aniline dye and started it towards its modern industrial prominence

Calco



Other difficulties arose from the benzene used in the preparation of aniline. This essential crude could not be then bought with a boiling point guaranteed within 20° and it was certain to contain practically everything but benzene: paraffins, cycloparaffins, and various sulfur compounds. The latter problem was solved by further rectification combined with a sulfuric acid agitation treatment. The sulfur compounds (thiophene, for instance) dissolved in the acid and were discarded. A policy of standard raw materials was decided upon as far back as 1916, and this coupled with a special setup of analytical laboratories for production control has assured quality throughout Calco's history.

By 1917, Calco was the country's largest producer of aniline. In the same year, the United States entered the World War. As a natural consequence of their position of aniline producer, Calco was asked to produce TNA, tetranitroaniline, tetryl as a bolster for the short supplies of picric acid and TNT. Calco built a plant with a capacity of 7500 pounds daily for the War Department. Along with the TNA plant itself, a unit for 20,000 pounds daily of nitric acid, and a plant for



Dye shop equipment at Calco *Calco*

80,000 pounds of sulfuric acid were erected. By dint of strenuous effort, the work was finished in partis within nine months.

Then, amidst the excitement attending the successful production of the first batches of TNA, came the Armistice! The Army ordered manufacturing operation stopped and the Government cancelled the contract. Calco made violent and frantic efforts to reorient their staff and production to peacetime use. But in peace the infant American dye industry slumped; sales dropped in expectation of foreign competition. The whole coal-tar market was upset, as former shortages became overwhelming surpluses. Prices plunged down — toluol from $1.50 to 25 cents, phenol from 43 cents to 11 cents. It was reported that there was enough benzol in the country to meet all demands for five years, enough phenol for ten.

The uncertainty was removed by the formation of the Chemical Foundation, Inc., by the American chemical industry. The man responsible for this quasi-public corporation was Francis P. Garvan who became its president. The Foundation purchased the 4500 German-owned American patents from the Alien Property Custodian and, for a small fee, leased them to any bona fide American manufacturer. Thus, the German Cartel no longer controlled the dyestuffs industry of the world; the fact that they had had a real strangle hold is illustrated by a comparison. The largest American dyestuffs manufacturer previous to the World War did not have one-tenth the resources of the smallest of the Six Companies combine, Badische-Anilin Fabrik.

From that time on, the American industry steadily expanded. In 1918, Calco became the first manufacturer of an important drug and medicinal, cinchophen in the United States. Thus, in the formative years 1915–1920, the pattern of Calco development and expansion was set. Intermediates, heavy chemicals, dyes and pigments and pharmaceuticals are the classes involved in the Calco scheme of things. Calco was the first commercial manufacturer of sulfanilamide in the country.

In 1929, the Calco Chemical Company became the Calco Chemical Division of the American Cyanamid Company. Calco itself has many subsidiaries. In Newark, the Heller & Merz Plant, producing ultramarine blue and other inorganic pigments, and the United Color and Pigment Plant, supplying various chromes and organic pigments, are among the oldest in the Calco family. In Virginia, a Damascus plant makes sulfur colors and alizarine reds and a Piney River plant refines domestic Titanium Dioxide. In Gloucester, New Jersey, a new plant will refine titanium dioxide ore from India. Recently Calco assumed ownership of the Marietta Dyestuff Company to add to the volume of intermediates and dyestuffs. Finally, the latest step in expansion has been to start construction on an eight million dollar plant in Willow Island, West Virginia, which is expected to be in operation by early 1947.

But that is only part of the story. Calco has also carried a huge program of research throughout all the years, developing its own manufacturing processes and producing new products.

Raw material arriving at Calco from the country's steel-plant coke ovens and gas works *Calco*

Automotive Chemicals

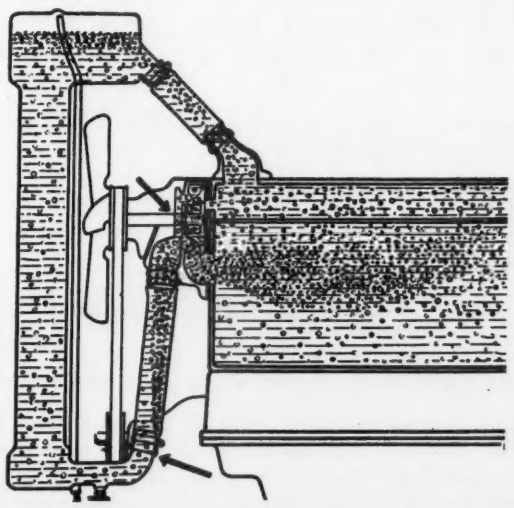
PART I. COOLING SYSTEM CHEMISTRY

By *ALVIN J. SITEMAN, '48*

THE cooling system of the modern automobile consists of five major parts:

1. Water jackets in the engine block and cylinder head through which the cooling liquid passes and absorbs heat from the engine.
2. A radiator for cooling water which has passed through the engine.
3. A fan which helps to circulate air through the radiator.
4. A centrifugal pump which helps to circulate air through the radiator.
5. A thermostatic valve which controls the flow of water through the cooling system.

The heat developed by the engine must be removed by heat transfer to the outside air through conduction and convection. The heat from the cylinders passes through the cylinder walls to the water in the water jackets. The heat picked up by the water is then lost to the air by means of the large surface area of the copper radiator core. The radiator tubes are about .005 inch thick to facilitate heat transfer. Since the



Suction of air into cooling system *SAE Journal*

heat removed from the car must pass through metal walls, good conductance is essential. For this reason the cooling system must be free from corrosion and rust. The temperature of the motor should be between 140° and 180° F. in order to prevent damage which results from "cold" or "hot" engines.

Improper operation of the cooling system may be caused by split or broken fan belts, a broken thermostat valve, leaky radiator hoses, a leaky radiator, a worn radiator cap and clogged overflow pipe, defective water pump, or worn gaskets. But in addition to these possible mechanical breakdowns there are chemical troubles in the form of rust, corrosion, and scale. Rust not only prevents efficient heat transfer, but it clogs the fine openings of the radiator core. Overheating results and the lubricating oil breaks down into heavy organic tars and gums which clog the engine. The final result is burned valves and other engine metals.

The common causes of corrosion of cooling system metals are oxygen from the air, dissolved minerals in natural water supplies, acids from exhaust gas leakage into the system, residual chemicals in the water jacket or radiator, undrained and unneutralized cleaning solutions, inorganic salt antifreezes, and some stop-leak preparations. Electrolytic corrosion is the result of combination of different metals in contact with one another as in alloys, soldered and brazed joints, metal gasket joints, and imperfect lead or copper plating on thin steel parts.

Experiments conducted by the Society of Automotive Engineers show that aeration of the cooling liquid definitely increases corrosion, particularly with iron and solder. Air entrainment results from turbulence of the water in the top tank of the radiator. In addition the water pump suction draws air through the system when the liquid level falls below the top of the radiator tubes.

Corrosion due to minerals in the cooling system liquid will vary due to the varying analyses of natural waters in different regions. The common salts causing corrosion are chlorides and sulfates of calcium, magnesium, and sodium. Chlorides are the most active and only two hundred parts per million will corrode cooling system metals. In tests conducted by the SAE, the average corrosion weight loss of non-ferrous cooling-system metals (aluminum, brass, copper, and solder) due to surface waters was only two per cent that of iron, and in saline well-waters ten per cent, the latter due to the increase in non-ferrous loss and decrease in iron loss with high-saline content. There is considerable danger of embrittlement, pit corrosion, and perforation of non-ferrous metals even though the weight-losses are small.

Of course acidity accelerates iron corrosion and rust formation, while alkalinity reduces the attack on iron. Acidity may be produced through decomposition of vegetable and animal matter in the water. Aerated distilled water can be even more corrosive to iron, copper, and solder than some high-saline waters.

There are several incidental contaminants such as zinc chloride solder flux and ammonium chloride used for sealing ferrous water jackets. Hydrochloric acid used as a cleaner is bad practice due to the high corrosion rate of chlorides and acids. Organic acids in stop leaks cause corrosion as does exhaust gas (acid) which leaks into the cooling system. Calcium and magnesium in inorganic salt antifreezes is detrimental.

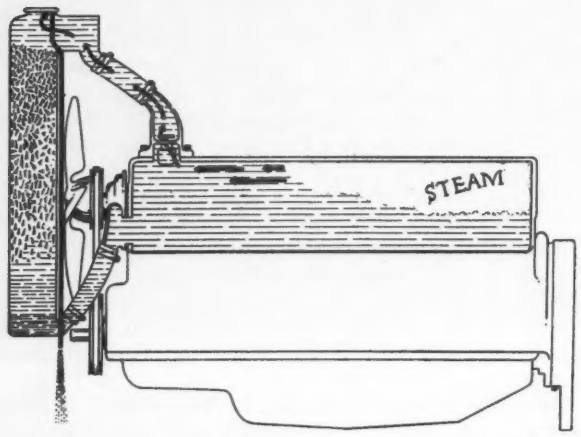
The rate of corrosion of iron is the highest at ordinary operating temperatures. Aluminum is attacked easily at slightly higher temperatures. For a temperature rise from 70° to 175° F., the rate of iron, copper, brass, and solder corrosion more than doubles. Laboratory tests indicate higher corrosion rates in all cases during warm-weather driving.

A recent survey showed that twelve per cent of all cooling-system troubles can be prevented by cleaning and rustproofing. The clogging materials in radiators and water jackets are about ninety per cent iron rust and the rest water scale and grease. The corrosion weight loss of iron is generally ten times that of aluminum,

copper, brass, and solder. Besides reducing heat transfer and circulation, rust shortens the non-corrosive life of antifreeze solutions.

Water scale formation is due to excess calcium and magnesium carbonates and bicarbonates in the cooling system. Silica also forms a tenacious water scale in combination with the calcium and magnesium salts. Special chemicals must be used to soften "hard" waters and to remove the water scale otherwise formed.

Rust inhibitors must be used to prevent corrosion. Suitable treatment of water will reduce the rusting at least ninety-five percent. The two types of water inhibitors in use are soluble oils and salts. These inhibitors only prevent the formation of rust, but do not remove rust already formed in the system. Good antifreeze solutions contain corrosion inhibitors. Formerly most radiator cleaners were of the alkaline type, such as washing soda, or organic solvents, such as kerosene. These materials cut grease and removed loose iron deposits, but they had little solvent action on rust itself. Oxalic acid and sodium bisulfate are now in common use. Whenever acids are used in cleaning radiators, it is necessary to neutralize the solution as soon as possible as metals dissolve in acid solutions.



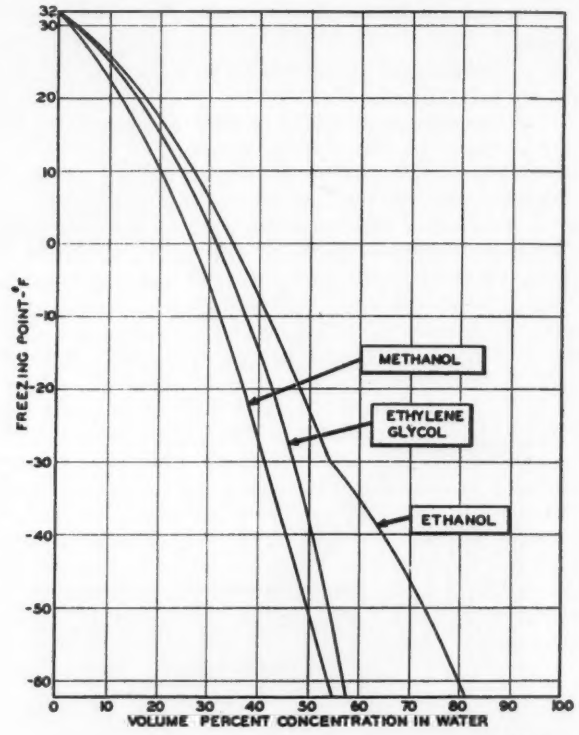
SAE Journal

Slush freeze-up in radiator and overheating from unmixed solution

Chromium compounds have been developed to protect metal surfaces as additives or electroplated. The original patents were for acid chromates and dichromates; not for neutral chromates. It was found that these compounds stained aluminum alloys and rubber, but that they remained intact. The work of H. Rohrig and K. Geier shows that sodium chromate added to phosphoric acid reduces the tendency of that acid to attack metals. However, any reducing agent in the cooling system may form chromium hydrate due to the lime present in the water. Sodium would be converted to the hydrate and aluminum would then corrode in the basic solution. So it can be seen that acid chromates act as inhibitors while neutral chromates may aid corrosion. To offset the corrosive action of sodium chromate, chromic acid could be added to the system. In either case there is no reaction with stainless steel or other metals usually in cylinder blocks or radiators.

Synthetic resins may be used to purify cooling water and keep it free from scale-forming compounds. Polyhydric phenol is a good purifier. It will extract metallic and acidic ions from water in varying amounts. To treat these ions, resins made from quebracho tannin with formalin and an acidic or basic catalyst present may be used. In order to remove acid ions another organic compound with formalin is substituted.

Metallic ions are removed with a chemical made by reacting equal parts of tannin and 40 per cent formalin with a 10 per cent hydrochloric acid cataylst, and the whole is warmed. When heated to 120° C., the gel which separates out dries to a dark hard mass. A second resin may be used to remove acid ions. It is prepared by dissolving metaphenylenediamine in water to give a 25 per cent solution and to this 40 per cent formalin is added. A great deal of heat is liberated by the reaction and a solid block is formed. Before using, these two resins are ground up to a fine powder and washed in distilled water, after which impurities in water are removed by running it slowly through a filter containing each resin. Metallic ions are first removed and then acid ions. In new automobiles, water initially run into the radiator and cylinder blocks should be so treated. No scale will form and all water subsequently added should be treated likewise. It is apparent that this treatment is troublesome and requires some time, making it impractical for general use.



SAE Journal

Freezing points of common antifreeze solutions

Chromium compounds should be used to remove the scale from old radiators. Resins will remove compounds from the water which will form deposits, while chromium compounds will dissolve calcium carbonate and remove existing deposits. Since the acidity of the compounds is of the chromic acid pH, metal surfaces do not corrode and resins will not deteriorate. However, chromium compounds require frequent additions.

Tests conducted on automobiles using the treatments discussed above show the following results:

At 30 per cent engine load the heat transfer was 1,191,000 Btu before and 1,389,000 Btu after treatment.

At 50 per cent engine load the heat transfer was 1,468,000 Btu before and 1,588,000 Btu after treatment.

Fuel savings tests showed marked differences over long periods of operation.

450 rpm at 9 mph: before treatment, 0.66 lbs/bhp of fuel consumed; after treatment, 0.57 lbs/bhp of fuel consumed.

(Continued on page 32)

Of Men and Mice

By ROBERT B. DAVIS, *10-46*

PERHAPS the day of crazy psychologists with long hair, bulging eyes, and moustaches is past. While the recent trend in motion pictures has served to interest the public in a saner sort of psychology, the successful applications of the experimental method in this field have given increased validity to psychologists' conclusions. If psychology seems at present any less satisfactory than, say, physics, this can be attributed to the greater complexity of most of its problems, and to the fact that no *electron* ever stood up and said, "No I wasn't, either!" The following experiments, chosen chiefly for their intrinsic appeal, illustrate somewhat certain problems of experimental psychology.

Experiment 1: Physiological Drives

In this experiment we want to measure the strength of "drives" or "motives." In order to measure these drives quantitatively, we use the following apparatus: a passageway is arranged between a white rat and the bait, so that the rat can reach the bait only by brushing past a charged grill from which he receives an electric shock. By varying the voltage, we can find how large a shock the rat will tolerate in order to reach his goal; at some point he will decide it's not worth while and resign himself to his fate. By using this "variable-voltage obstruction method" and appropriate bait, we can obtain such results as the following:

Drives (in order of strength)	*Bait*
1 maternal	new-born litter
2 thirst	water
3 hunger	food
4 sex	rat of opposite sex
5 exploratory	"mysterious" compartment

Also, it was found that the hunger drive, and the sex drive in males, increase with increasing length of deprivation period up to a point, after which they start to decrease. In the female, the sex drive is dependent only upon the phase of the oestrous cycle, and is completely unaffected by changes in the period of deprivation.

We can see at once that this experiment presents certain difficulties. However much as we may sometimes think that people behave like rats, there is little valid justification for such an assumption here. We must devise a similar experiment for humans; but we cannot readily change this set-up for people, if only for the very good reason that it was performed under laboratory conditions — a fact of which the rats remained conveniently ignorant. Also, if we want to talk about each drive separately, we are confounded by the fact that each rat, in each case, was responding to a multiplicity of drives; when we set up the mysterious compartment for bait, perhaps the rat was just a little hungry, and was not really exploring just for the fun of it — he was looking for food. If we had fed him until he did not want even a morsel more, we should have created a need for water and a need for elimination. Even if we had been able to satisfy all these needs (except the desire to explore), we might not have succeeded; he might simply have gone to sleep. By the time he had satisfied his desire to sleep, we should have needed to start all over. Finally, in evaluating our results, we must remember the method used to test the rat's drive: perhaps in a state of sexual excitement, for example, the rat's values were shifted somewhat; he may even have derived some pleasure from the sensation of the electric shock. Our experiment, then, leaves us somewhat dissatisfied — and it may seem doubtful whether an experiment of this general type ever can prove entirely satisfactory. But undaunted, we bravely try again.

Experiment 2: The Effects of Tobacco

This experiment illustrates two important points: we must often maintain some sort of "control" in order to make comparisons, and we must attempt to eliminate other factors which might interfere with our results. For example, it is often found that the method of administering a drug will produce results which we can easily mistake for those of the drug itself; thus people stay awake after drinking coffee with most of the caffein removed, but sleep soundly after drinking milk "spiked" with a multiple dose.

For a control, then, we must have a device which will appear to our subjects to be an ordinary pipe giving an ordinary smoke. A "pipe" was devised which felt to the lips like an ordinary pipe, and which permitted the subject to draw warm, moist air. The subjects were led to believe that they were always smoking tobacco, and the experimenter even smoked in the room himself, so as to provide a faint odor of tobacco smoke. The experiment was performed in a dark room, with the subjects blind-folded, and the subjects were not permitted to handle the pipes. On certain days they smoked tobacco, and on others they "smoked" hot air; this provided the "control," for it was now possible to compare results on the "tobacco" days with the results on the "hot air" days. After a period of smoking (twenty-five minutes, three puffs every twenty seconds), the subjects were tested for steadiness, speed of adding numbers, and speed of learning. Tobacco produced unsteadiness, increased the speed of adding, and produced no change in the rate of learning. All the smokers found the smokes satisfying, and one subject even insisted on blowing smoke rings on the nights when there was no smoke — a stunt possible only to men who are blind-folded. Notice that although the conditions here were highly artificial, this did not interfere with the results, for the conditions were real enough in all points where it mattered to the experiment.

Experiment 3: Fear of Snakes

Here is an experiment that should satisfy most sadists. Many adults have so intense a fear of snakes that they can not believe that it is acquired — while scientists hesitate to assume that it is inherited without some experimental proof. The following experiment shows that we *learn* to be afraid of snakes! A play-pen was placed on the nursery floor, and in it were placed the child-subject, a few toys, and a six-foot *Spilotes carais*, concealed in a suitcase, from which he was to be released at the proper time. The following is an account of one trial, which was typical:

Subject sat in pen, playing with toys. Snake, when released, moved swiftly about enclosure. Subject showed no interest, and continued playing, even when snake was two feet away. When snake was held directly

in front of the subject's face, subject reached out and grabbed it tightly about the neck, while showing no signs of emotion.

When older subjects were used, many showed intense fear, and practically none were unaffected. Although the conditions here were, with the older people at least, somewhat unnatural, they again did not interfere; however, the whole question was sufficiently overt so that subtle procedure was not required.

The naturalness of the conditions in the next experiment should be clear.

Experiment 4: Suggestion

The chemist, E. E. Slosson, brought into one of his lecture classes a bottle of a liquid whose vapor, he explained, had a very penetrating odor. He wanted to test its rate of diffusion, and asked the students to co-operate by standing up as soon as they could notice its odor. Gradually each row stood up, until the entire class was standing. You have probably guessed that the bottle contained distilled water.

This experiment illustrates an attempt at performing our test in the subject's life field, instead of in the artificial atmosphere of the laboratory. At present, very elaborate attempts at such naturalness are proving extremely rewarding. In some experiments, of course, "naturalness" has no meaning; the next experiment is a case in point.

Experiment 5: Perception Phenomena

One psychologist wished to test the significance of the fact that the human eye is a simple optical system, and hence the image of whatever we see appears upside-down on the retina. Suppose it were not; if man had been made differently, would he see the world wrong-side up? The experimenter had simply to wear an inverting lense for several days — continuously — and to observe the results; if, after a long period, things still refused to look right, there might be some doubt. But if instead he gradually became acclimated to the new visual arrangement, then he would have shown that the type of eye was arbitrary, and that we merely *learn* to tell, by looking at objects, whether we are standing on our heads or not. At first, he could pour milk only by concentrating on the level of the surface and the top of the glass, he could pick up objects better if he did not look at all, and the whole thing made him feel decidedly sick in his stomach. Furthermore, sounds never seemed to come from the objects which made them: the fire sputtered in one place, and gave off light in another. However, after only eight days, signs of nausea disappeared, and the fire lost its double existence, although it would be too much to say that the world had completely righted itself. The indications, though, are that it would in time, although the learning of many years could not be obliterated in only a week.

United Artists

Part of the movie's current campaign to popularize psychiatry, a scene from the film "Spellbound"

Experiment 6
The Effect of Noise in Distraction

This experiment shows beautifully how an enthusiastic experimenter can influence the outcome of an experiment, and hence explains the discrepancies between many conflicting experimental results. In particular, it had been found that noise served to increase the rate at which a person could work. It had also been found that noise served to decrease this rate.

The "work" which each subject was to do consisted of adding successively 6, 7, 8, and 9 to whatever two digit number he was given, calling out each sub-total; thus, given 21, he would say 27, 34, 42, 51. The noise was supplied from a loudspeaker; each day's work was done partly in silence and partly with noise; the silence period came first on some days, second on others, in order that the effect of this difference might be eliminated.

The subjects were divided into four groups. The first was told nothing about the expected results; the second was told that they were attempting to check previous results which had showed that noise facilitated performance; the third was told that previous experimentation had shown noise to be a hindrance; and the fourth was told that it was believed that the noise would be a hindrance at first, but that after they became accustomed to it, it would prove to be helpful. The first group showed no consistent difference between quiet and noise, and every other group checked exactly the results that they thought had been previously obtained! The moral to all who would experiment in psychology is clear: just decide what results you want, and then tell your subject; he will probably come through.

Experiment 1 was performed by F. A. Moss. An account appears in the *Journal of Experimental Psychology*, 1924, 7. Experiment 2 is a slightly simplified version of an experiment performed by Clark Hull, and reported in *Psychological Monographs*, 1924, 33. Experiment 3 was performed by H. E. Jones and M. C. Jones; see *Childhood Education*, 1928, 5. Experiment 4, by the chemist E. E. Slosson, appears in *Psychological Review*, 1899, 6. Experiment 5 was performed recently by G. M. Stratton. Experiment 6 was performed in 1937 by Kenneth H. Baker, and can be found in the *Journal of General Psychology* of that year.

Fluid Catalysts

By RODMAN JENKINS, 10–46

NOT so long ago, there were 2,000 plane forays over Europe nearly every day, and hundreds of B-29's were flying 2,000–3,000 miles on raids over Japan. Each day's operations consumed enough high-octane gas to float a small ship. And if every gallon was not equal to, or better than that the enemy used, our fighters might not be able to take the tight turns the Germans could, or the B-29's might not be able to maintain the 35,000 feet-plus altitude that kept them over the flak. Fluidized powder processes were a vital part of the industry that provided all this fuel.

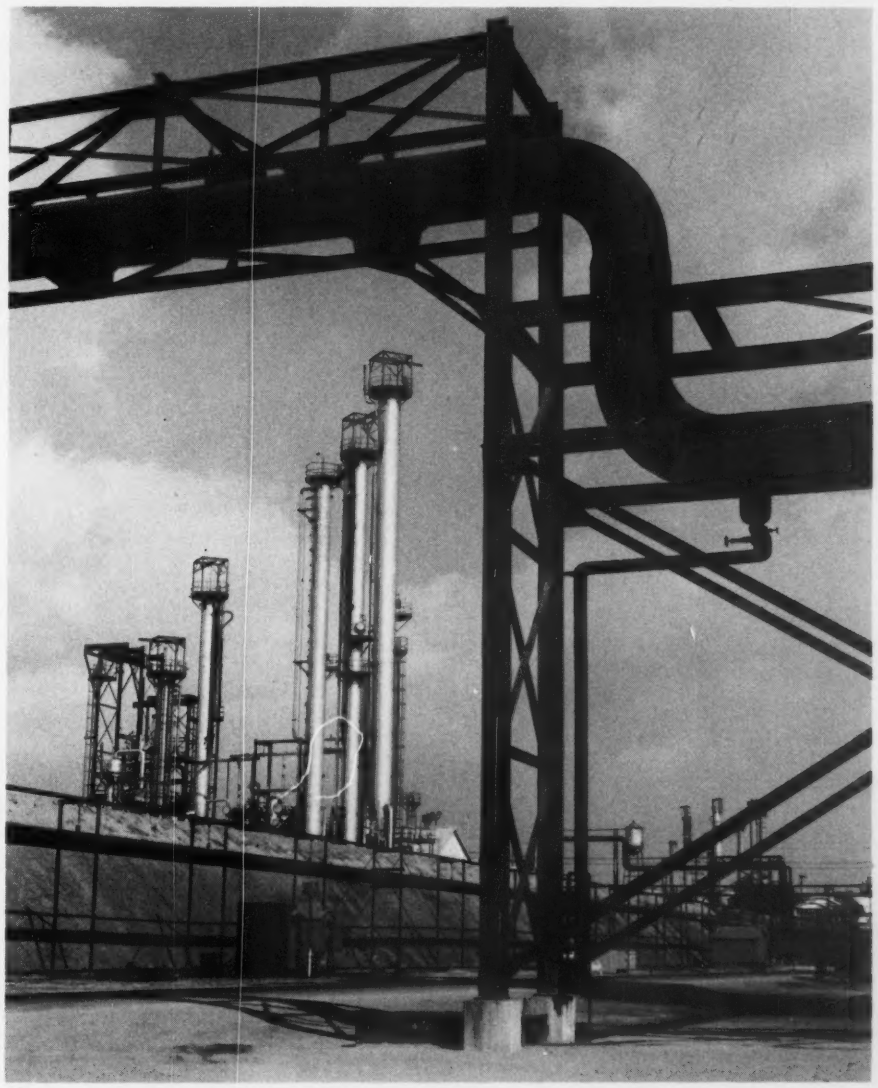
They were first developed by the oil companies before the war for use in their huge "cat" crackers. While the basic cracking process was used commercially about the time of the first World War, the methods of making high octane gas were not touched upon until shortly before the present war broke out. When catalysts were found that would yield a product of sufficiently high octane number, they were found to give a reaction rate that was too slow to use as matters stood then. Mass production of aviation gas for the war would necessitate greatly improved catalyst technique. Since the rate of any such reaction is proportional to the surface area of the catalyst exposed, some method of handling the catalyst was needed that would boost the available area.

The solution to the problem that was worked out was called "fluidizing." The catalyst was finely powdered and suspended in the reacting gases. Not only was more total surface area exposed to the reactants, but the active fraction of what was exposed was increased. By-products of the cracking had been gumming up the catalysts, but now, because the catalyst could be handled more easily when suspended in a gas, the deposit could be removed more frequently. Three different methods of fluidizing are used, which will be described separately below.

In the first method, called the "Thermofor" process, solid catalyst is fed into the top of a large reactor. Because of the upward velocity of the vapor mass, settling occurs very slowly. Mixing is excellent because of the turbulence in the mixture. After the catalyst reaches the bottom of the reactor it is removed as a solid and elevated to the top of a regenerating tower, where it settles as it did in the reactor. It is regenerated by hot air, entering the bottom, which burns off the deposit. From the bottom of the regenerator, it is transferred back to the reactor, completing the cycle.

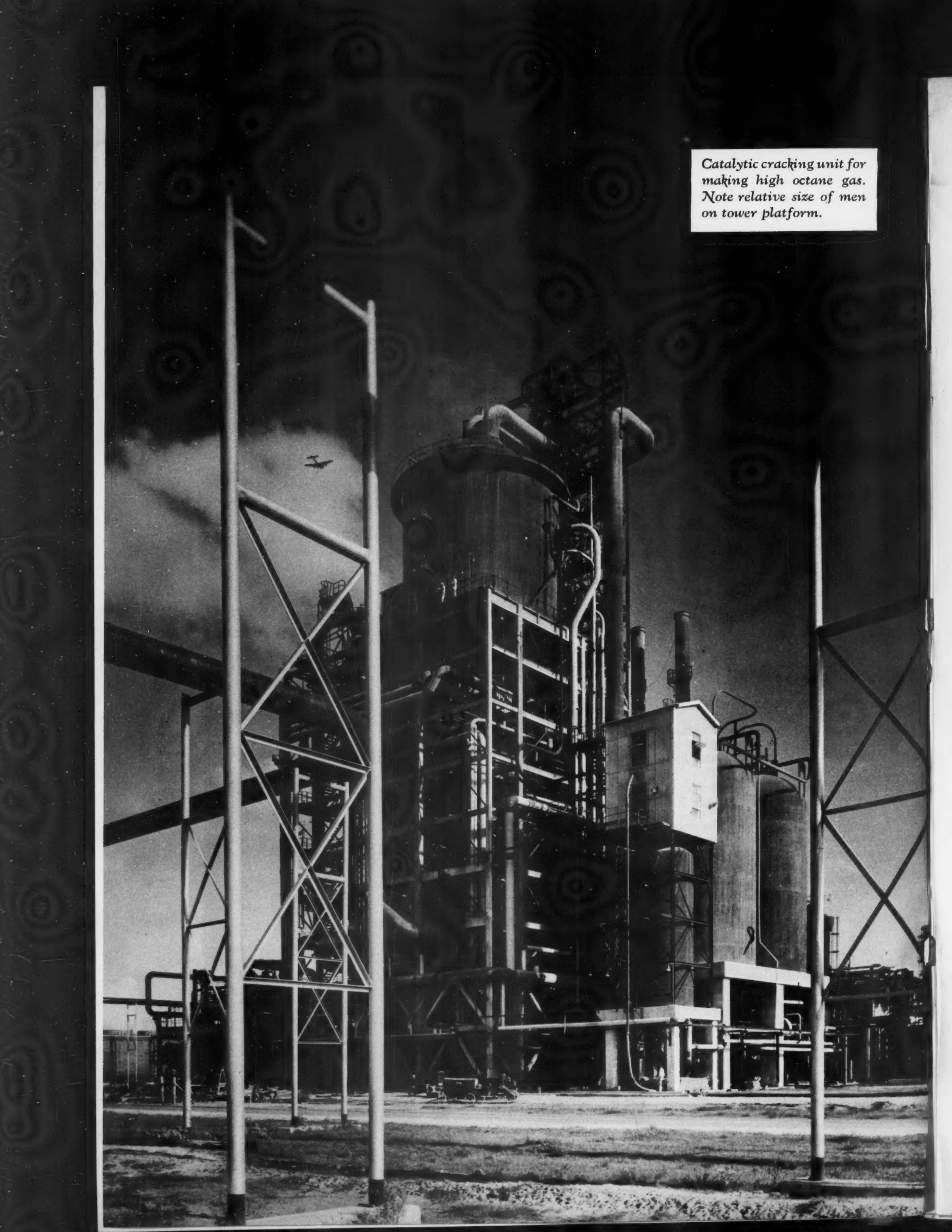
Another refinement of the same idea is designated as the "fluid process." Here, the solid is carried in the main body of the flowing vapor, and enters the reactor at the bottom. It is kept suspended in the pipes by maintaining in them a high velocity, turbulent flow. The rate of flow in the reactor is also greater, so that the catalyst drifts slowly out the top with the reaction products. Coming out of the reactor, the catalyst is allowed to settle into an accumulator while the product flows on. The dead catalyst is sucked from the accumulator by a rapidly moving stream of air, which carries it into a regenerator to burn off the contamination. After leaving the regenerator, the solid settles into another accumulator, from which it is sucked into a stream of unreacted vapor, completing the cycle.

A third method, involving no transfer of catalyst, called the "fluidized fixed bed" technique, was developed after the war had started. Before gas flow starts, the catalyst or solid to be reacted is placed on a screen in the conical bottom of a tube greater than two inches



The Texas Company's Los Angeles Alkylation unit

The Texas Company



Catalytic cracking unit for making high octane gas. Note relative size of men on tower platform.

in diameter. The reacting gas is then blown into the tube through the screen, carrying the powder into the middle portion of the tube. The solid then remains stationary under the influence of gravity while the gas flows past. If it is being consumed in the reaction, it is added continuously at the bottom. If it is a catalyst when the need for regeneration arises, the flow of reactant gas is stopped and hot air takes its place, burning off any carbonaceous matter on the catalyzing surface.

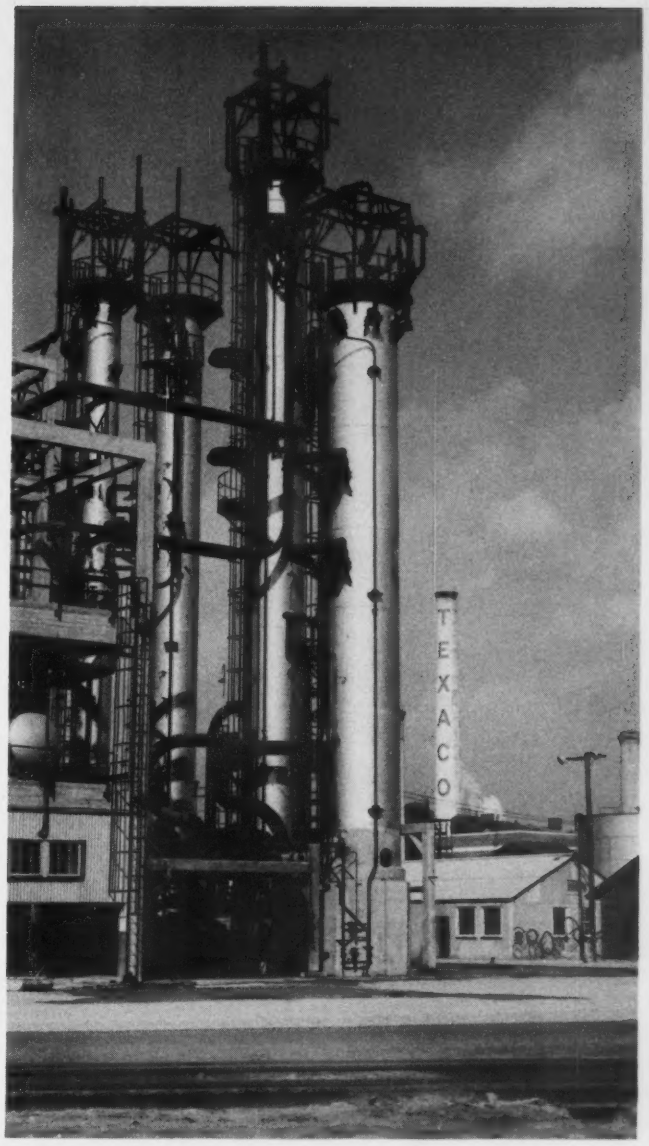
The opportunity that these techniques offer industries involving gas-solid phase reactions of all types is not being neglected. Three prominent applications are in the calcining of limestone, the manufacture of producer gas, and the manufacture of water gas.

In the production of lime, fluidization increases greatly both the efficiency of heat transfer to the stone and the rate of the reaction. Limestone is fed into the top of a chamber in which producer gas is burning. The heat of the combustion is transferred almost instantaneously to the limestone in the combustion zone. Running counter-current, the decomposition easily occurs in the producer gas, which is relatively free from carbon dioxide. The lime is allowed to settle to the bottom for removal. Now being investigated is the possibility of introducing powdered coal with the limestone and carrying out all the combustion and the decomposition in the same place. The ashes, because of their lower density, tend to leave through the top, while the lime again settles to the bottom.

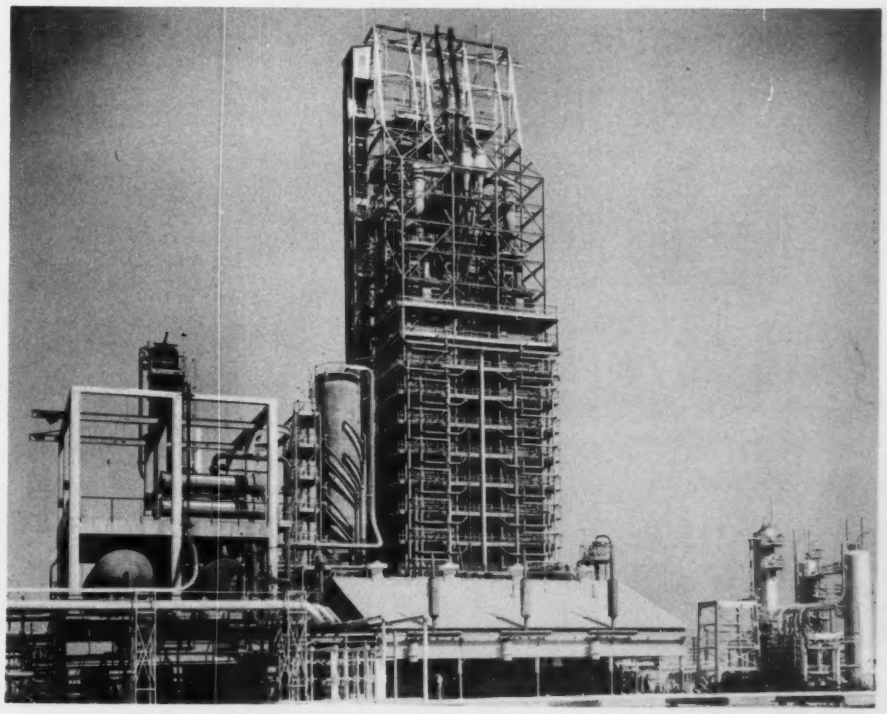
An experimental fluidized producer gas unit is in operation now right here at M. I. T. Powdered coal enters the combustion chamber at the bottom with the air stream. After the coal has burned, the ashes settle out, and are removed at the bottom. Powdered coal for this unit is very cheap, because it cannot be fired in ordinary furnaces.

Water gas production is still in the experimental stage. Fluidization will permit continuous operation in water gas production, which has not yet been achieved by other methods. As the water gas reaction is endothermic, it has been necessary to blow alternately steam and air through hot coal. The steam would react to form water gas, which would cool the coal; then the air would come in and the coal would burn, becoming hot again. Using the fluidized technique, sand and coal are blown into a reactor where the coal burns, raising the sand to a high temperature. The emerging sand settles away from the ashes into an accumulator tank, from which it is drawn into a stream of powdered coal and steam entering a reactor. The hot sand furnishes the necessary heat, and water gas is produced. The sand is separated from the ashes as before, and returned to be reheated.

One can easily see that these are only a few of the reactions to which fluidization can be applied. A whole new series of solid-gas phase reactions is now practicable. As promised postwar industrial techniques come before the public eye, we are sure to see fluidized powder processes among them.

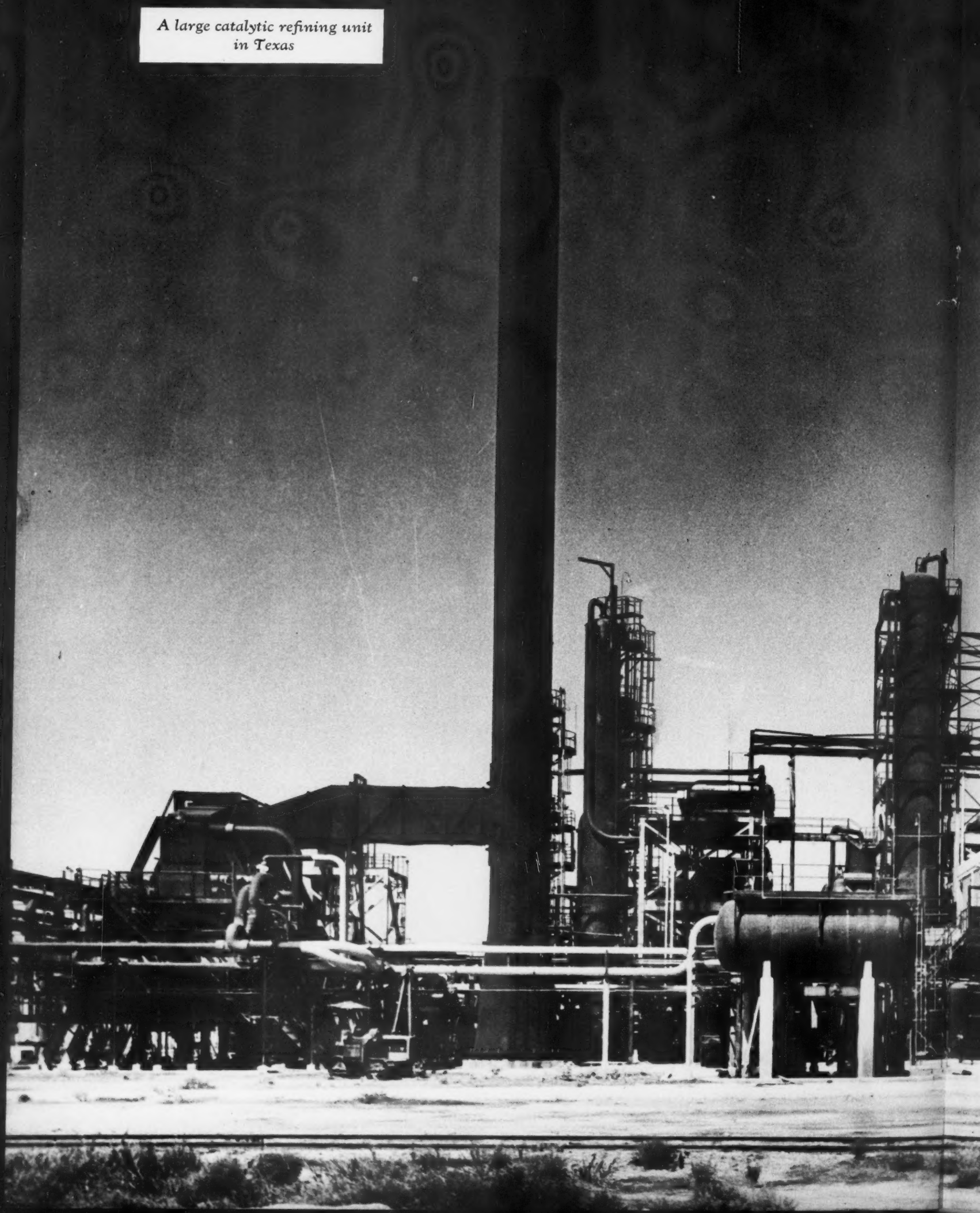


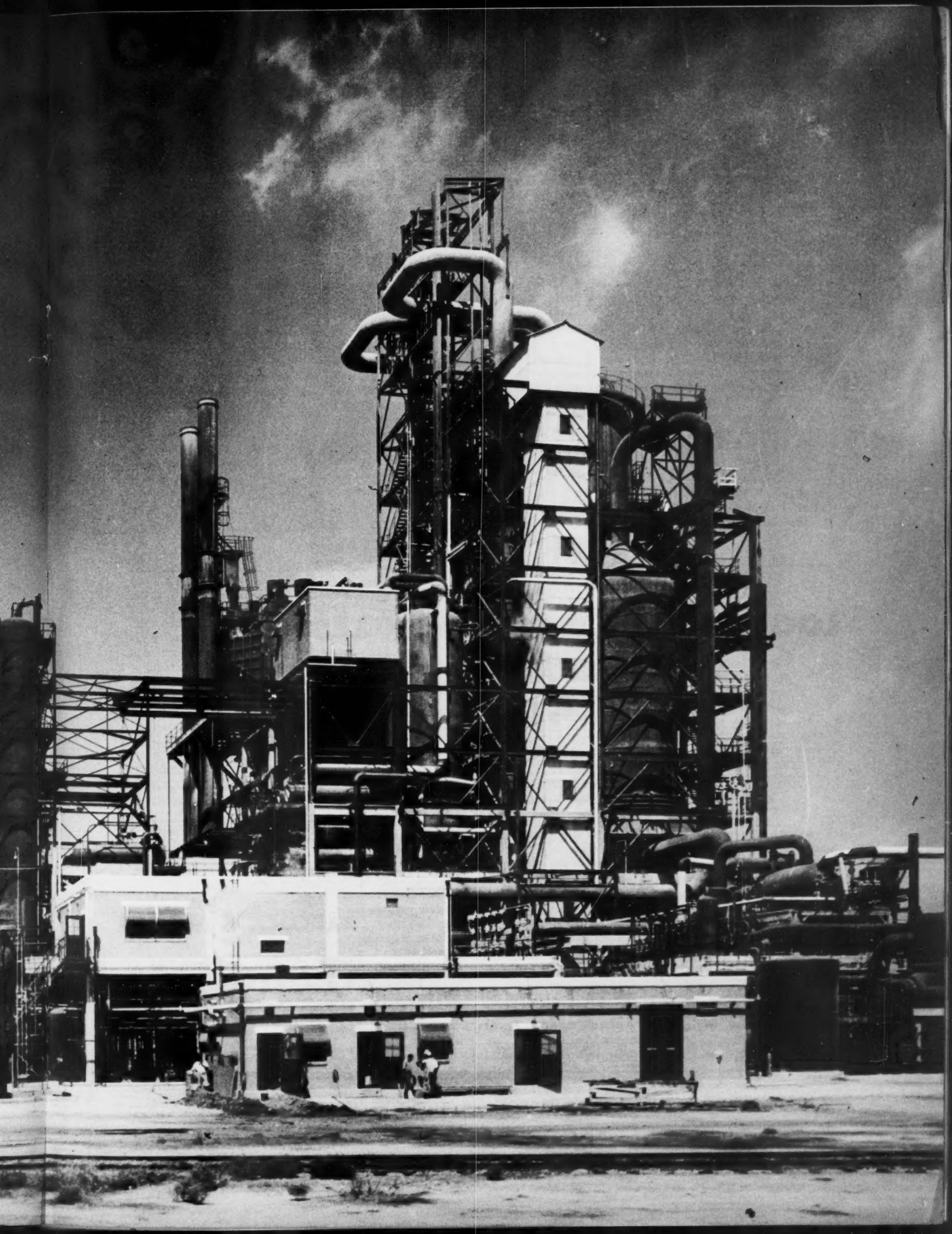
Cat cracker — *The Texas Company*



A view of the first Thermofor cracking installation to be located in the United States — *Socony-Vacuum Oil Co., Inc.*

A large catalytic refining unit in Texas





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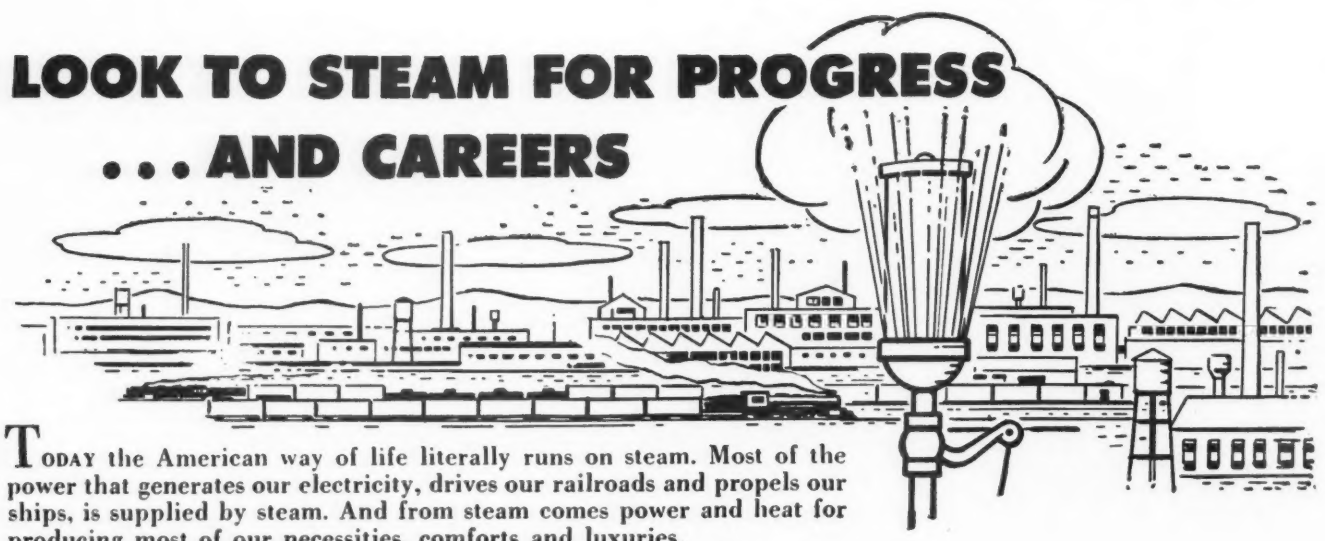
LOOK TO STEAM FOR PROGRESS . . . AND CAREERS



TODAY the American way of life literally runs on steam. Most of the power that generates our electricity, drives our railroads and propels our ships, is supplied by steam. And from steam comes power and heat for producing most of our necessities, comforts and luxuries.

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The Dragon's Den

Like so many other educational institutions around the country, M. I. T. this fall finds itself with a record number of undergraduate students. The five thousand postwar, prospective engineers who returned to continue their studies this term are finding difficult conditions beyond any equal in the Institute's history. Classes are full to overflowing, living space is crowded and, in many cases, extremely inconvenient, and a generally hectic atmosphere prevails. For men living in temporary housing, studying has become more and more difficult with classrooms often serving extra duty at night as the only available spots in which to do the next day's homework.

And it is right in the middle of these conditions that THE TECH ENGINEERING NEWS finds itself starting its twenty-eighth volume. Paradoxically enough this postwar situation appears to contain both advantages and disadvantages. For while costs of operation — like all other costs today — are extremely high, the chances are very favorable for presenting much new scientific material, released from the restricted lists by the end of the war or, even more important, contained in the minds of the increased number of potential scientists near at hand. This last great source of information and interest can, if properly developed, far outweigh in importance the financial and mechanical difficulties sure to occur in *T. E. N.*'s future. In order to begin developing this potential mine of ingenuity — our huge student body — we would like to try and show where *T. E. N.* fits into the picture as a part of student life, how it can help mould individual ideas and provide a means of circulation for these ideas.

We believe that our main purpose is twofold. It is our job to present to our readers articles on science and engineering that are both interesting and educational, articles that are fresh and alive and not simply condensed from some textbook. Furthermore, it is our job to attempt to provide the undergraduate body at the Institute with a technical magazine as fine in all respects as any in the country, a magazine which should be that body's organ for expression of new thoughts and for the preservation in picture and in print of important events of a scientific nature. *T. E. N.* is M. I. T.'s journalistic connection with other colleges and universities, as well as with high schools, throughout the country. Among the other schools' publications *T. E. N.* is regarded with interest and, sometimes, with envy. That is not bragging, but fact. It is because of this past reputation and because of the need which our greatly expanded student body possesses for such a publication to continue and to improve, that we feel so deeply the tremendous responsibility that has been thrust upon us.

But it must also be remembered that if *T. E. N.* is to be a magazine for the student body, it must also be of the student body — not solely of the few individuals which at present constitute its staff. In spite of the fact that *T. E. N.* purports and hopes to represent the student body, it only directly represents about one-half of one per cent of the total.

Therefore, in order to do a better job in the future, to more fully represent the undergraduate section of the Institute, we must have the co-operation, directly or indirectly, of every one of these students. This does not mean that we aspire to a staff of five thousand or even that this editorial is intended as a sort of written recruiting poster. What it does mean is this: we need your co-operation to the extent of mentally recognizing *T. E. N.* for what it is. We want to be regarded as your magazine in the true sense of the word, that is, not only a magazine which you, as a student, read, but one which you can justly feel represents you to a definite degree, one which you have had a part in producing, however remote that part may have been. *T. E. N.* should be the place to which you as an undergraduate could come with any ideas you would like to see printed — if only to get comment and criticism from others around the country who are interested in the same type of thing that you are. Try and remember that. We are your publication and, as such, are only trying to satisfy your wishes. But we cannot continually direct our policy by means of an Ouija board; we need to hear from you in some concrete form, whether it be criticism or suggestion for new features or types of articles.

Just think of it this way. As a student of one of the best engineering colleges in America or the world, you certainly want to be represented among the various college publications as befits such a reputation. But remember that we cannot do it for you. You must do more each month than plunk down your coin and resignedly carry off your copy, thinking to yourself how much better the magazine really should be. It is up to you to make it the way you want it. So let us hear from you soon, one way or another. Can we count on you?

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AUTOMOTIVE CHEMICALS

(*Continued from page 20*)

850 rpm at 18 mph: before treatment, 0.55 lbs/bhp of fuel consumed; after treatment, 0.51 lbs/bhp of fuel consumed.

1100 rpm at 25 mph: before treatment, 0.57 lbs/bhp of fuel consumed; after treatment, 0.54 lbs/bhp of fuel consumed.

Since radiator maintenance chemicals are inexpensive, it is definitely worth while to use them the year round to guarantee better engine operation and to prevent damage to the engine.

In addition to cleansing treatments of the radiator, it is very important to use antifreeze solutions in cold weather to prevent freezing of the cooling liquid and cracking of the radiator or cylinder blocks. Water is used as the cooling liquid because it is plentiful and because of its high heat transfer properties. However, it freezes at 32° F. and corrodes metal if not properly treated. Antifreeze solutions should lower the freezing point of water sufficiently; should not reduce the cooling effect of water; and must have a satisfactory chemical stability and the ability to protect cooling-system metals from the corrosive action of water.

The commonly used antifreeze materials are ethylene glycol, ethanol (denatured ethyl alcohol), methanol (synthetic methyl alcohol), and isopropyl alcohol. Other chemicals are added to prevent corrosion. All of these antifreeze solutions are organic and nonelectrolytic.

Nonrecommended materials include oils, sugars, and inorganic salt solutions. The objections to inorganic salt antifreezes are electrical conductivity and corrosive effects. Leakage into the ignition system would cause serious shorting of the electrical circuit. The possibility of crystal formation in the radiator is objectionable. Petroleum oil distillates such as kerosene are low freezing liquids, but they cannot depress the freezing point of water as they do not mix with it. Oils have low heat transfer properties and their vapors are inflammable, which presents a real fire hazard when boiling and overflow occur. Mineral oils have a solvent action on rubber and they would rapidly deteriorate the rubber hose connections and rubber seals in the water pump. Sugar solutions including honey and molasses become viscous at low temperatures and prevent circulation. Charring

(*Continued on page 42*)

Harnessing the Power of Niagara

For thousands of years, water had roared over Niagara Falls at the rate of about *200,000 cubic feet per second* —representing enough power to supply the annual requirements of *24,000,000 average homes.* This enormous power continued to go to waste until...

In the late 1880's, a group of world-famous engineers began to study the problem of harnessing the vast power of Niagara Falls.

A bitter controversy raged for years as to whether *alternating* or *direct* current should be used. George Westinghouse, the world's greatest authority on alternating current, vigorously supported the *a-c system.*

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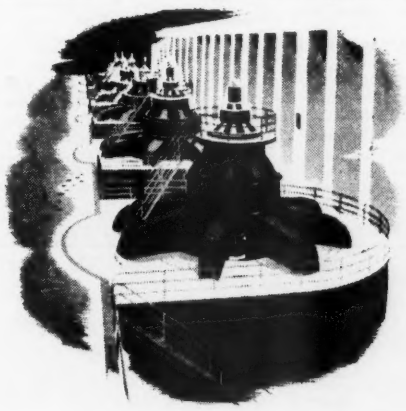
It was a major victory for mankind as well as for George Westinghouse—for it *set the pace for power development all over the world.*



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TODAY—The Westinghouse Electric Corporation supplies much of the world's needs for the generation, transmission and utilization of electric power. For instance, throughout the world there are Westinghouse water-wheel generators with a total capacity of more than 12,000,000 kva. In addition, steam and engine-driven generators, with a combined capacity of *many more million kva,* proudly bear the Westinghouse name plate.

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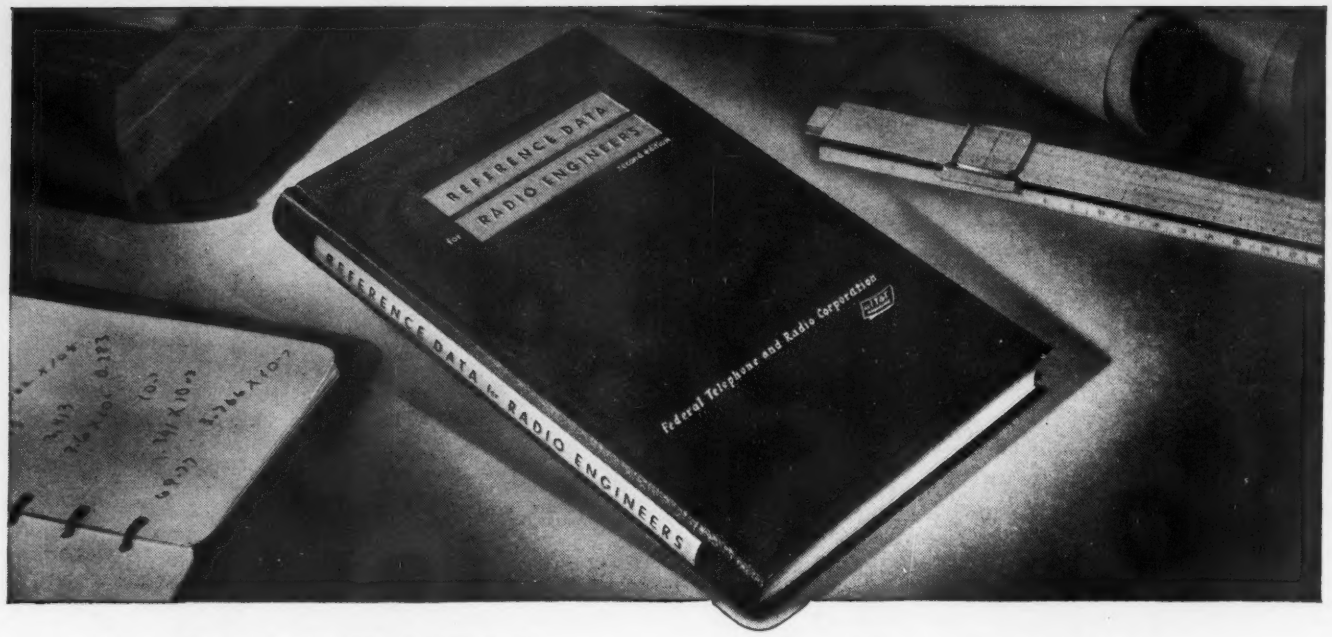

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"REFERENCE DATA *for* RADIO ENGINEERS"

Compiled especially for Radio Engineers, Students of Engineering, Educators, Electronic Technicians, Radio Amateurs, Inventors.

The second edition of this widely accepted pocket-size handbook . . . revised and enlarged . . . now includes important radio technical data developed during the war.

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Enlarged from 200 to 336 pages with over 400 charts and diagrams, it makes available quickly the answers to problems that normally arise in practical radio work. This ready reference feature is one reason why *Reference Data for Radio Engineers,* in its earlier edition, received such an enthusiastic welcome by electronic specialists. Orders totaled more than 50,000 copies. With the wealth of new material now included, the second edition can be of even greater aid to the practicing radio engineer.

Commenting on the first edition, Walter J. Seeley, Chairman, Department of Electrical Engineering, Duke University, wrote enthusiastically:

> ***"It is so chock full of useful data that I am urging all students to purchase their own personal copies . . . fills a long-felt need for a convenient compilation of both mathematical and engineering data, and the combination will be appreciated by all who have to work with radio circuits and their concomitant mathematics. That applies especially to teachers and students and I should not be surprised if it becomes a must in many college courses."***

The new, second edition of *Reference Data for Radio Engineers,* in green cloth binding, revised and enlarged to include much new data, is ready now. To order, merely fill in the convenient coupon.

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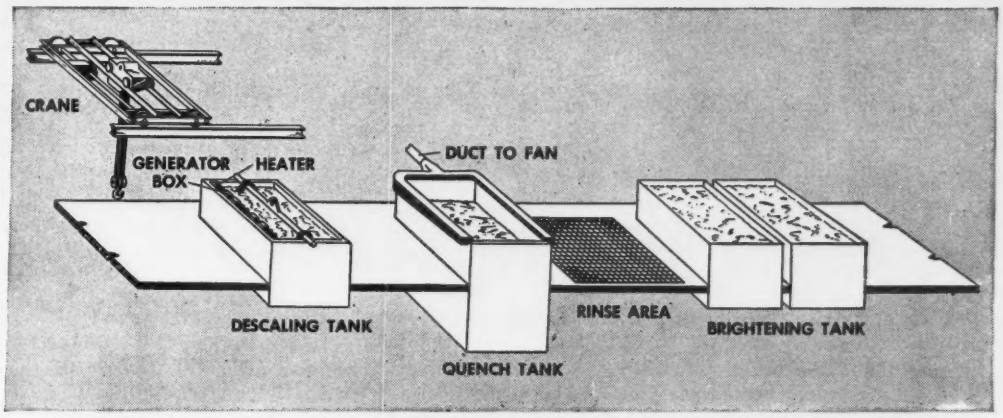
Du Pont Digest

Items of Interest to Students of Chemistry, Engineering, Physics, and Biology

Chemistry Finds Better Way to Descale Steel

One of the most bothersome problems in the metal industry is the removal of scale from the surface of stainless steels and other alloys. Scale is a thin film of metal oxide which forms at high temperatures during fabrication or processing. It is very abrasive to dies and other metal-forming tools, and if not completely removed causes serious flaws in the surface of finished products.



A typical layout showing arrangement of equipment for sodium hydride descaling. The usual treating cycle comprises sodium hydride treatment, water quench, water rinse and acid dip for brightening.

Several years prior to World War II, Du Pont chemists, engineers and metallurgists went to work on the problem of developing a quick and positive descaling process. When success came three years later, a secrecy order prevented its public announcement at that time—the discovery went directly into war work.

Process Development

In developing the process, a group of Du Pont Chemists found that small amounts of sodium hydride, dissolved in molten sodium hydroxide, effectively removed scale without attacking the base metal or embrittling it. However, the problem then arose of finding an efficient and economic means of obtaining the sodium hydride. This was accomplished by developing an ingenious apparatus for forming it directly in the molten sodium hydroxide (700° F.) from metallic sodium and gaseous hydrogen.

Metal chambers, open at the bottom, are placed along the inside of the descaling tank and partly immersed in the bath. Solid sodium is introduced into these chambers, and hydrogen gas bubbled through. The sodium hydride formed is diffused uniformly throughout the molten caustic.

Practical Application

The metal to be descaled is immersed in the bath which contains 1.5 to 2% of sodium hydride. Scale is reduced to the metallic state for the most part in from a few seconds to twenty minutes, depending on the size and type of material.

The hot metal is then quenched in water, and the steam generated actually blasts the reduced scale from the underlying metal. A water rinse and a short dip in dilute acid complete the process and produce a clean bright surface.

This process has been called the most significant development in the cleaning of metal surfaces in decades. It is representative of what men of Du Pont are doing to help American industry to better, quicker, more economical production methods.

• • •

MAN-MADE SPONGES PRODUCED BY DU PONT CHEMISTS

Among the most versatile members of the family of cellulose products—whose members include rayon, cellophane, lacquers and plastics—is the synthetic sponge.

Du Pont cellulose sponges have many of the attributes of the kind that grow in the sea, plus several additional advantages. For example, quality can be kept uniform; texture and hole-size can be predetermined; they can be cut to handy shapes, and they may be sterilized by boiling.

The complicated 10-day manufacturing process starts when viscose is produced by adding carbon disulphide to alkali cellulose (from wood or cotton), and dissolving the mixture in water and mild alkali. To produce holes, crystals of the desired size are introduced. Heating in a salt solution hardens the viscose and dissolves out the crystals. Washing, centrifuging and oven-drying complete the operation.

Questions College Men ask about working with Du Pont

"DOES THE DU PONT COMPANY EMPLOY ENGINEERS?"

There are many diverse opportunities at Du Pont for engineers. Principal requirements are for chemical and mechanical engineers, but opportunities also exist for industrial, civil, electrical, metallurgical, textile, petroleum and others. Practically all types of engineering are included in the work of the manufacturing departments and the central Engineering Department. Openings for qualified engineers exist at times in all of these departments.

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BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

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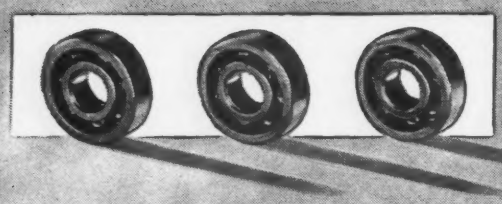
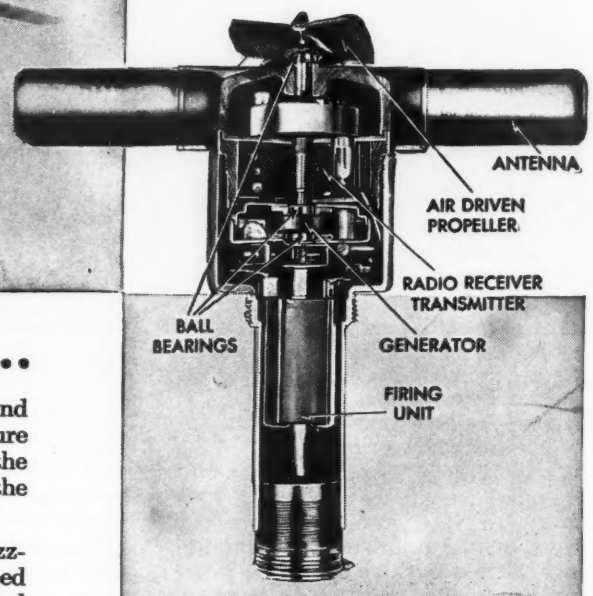
More facts about Du Pont—Listen to "Cavalcade of America," Mondays, 8 P.M. EDST, on NBC

Three little ball bearings



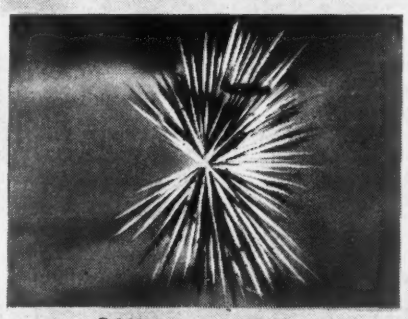
...and how they flew at 100,000 RPM!



Generator-Powered Bomb Fuze

Sponsored by O.S.R.D. and the U. S. Army with Central Laboratories at the NATIONAL BUREAU OF STANDARDS.
Below: V.T. Fuzed Rocket in action

SENSITIVITY PATTERN



BURST PATTERN

Pictures courtesy of National Bureau of Standards

STORY OF THE VT (Variable Time) FUZE...

America's VT or Proximity Fuze is a wonder of the war second only to the atom bomb. In the nose of a projectile, its miniature sending and receiving set sends radio waves ahead. When the target is neared, the waves bounce back and — before the projectile can miss—they explode it!

This "Seeing Eye" feature was 97% effective against V1 buzz-bombs...helped clear the Pacific beaches for invasion...helped turn the tide in the Battle of the Bulge . . . raked the mainland of Japan . . . and was deadly against Jap Kamikaze planes.

On land, at sea and in the air, it gave us a super-accuracy of fire that saved countless American lives and materially shortened the war.

...AND THE VT (Very Tough) BALL BEARINGS THAT HELPED MAKE IT POSSIBLE!

But to make such miracles possible, bearings on the fuze's rotor and impeller shaft must withstand *100,000 revolutions per minute!* Could *any* bearing "take" such speeds and centrifugal force?

New Departure designed ball bearings that could—and *did.* They stood up . . . just as rugged New Departure Ball Bearings stand up *wherever* shafts turn.

New Departure Ball Bearings are uniquely fit to handle great speeds—as well as heavy loads and requirements of super-rigidity . . .

. . . but there is more to a ball bearing than steel and engineering principles. New Departure, world's greatest ball bearing maker, is also famed for *solving problems!* 3423

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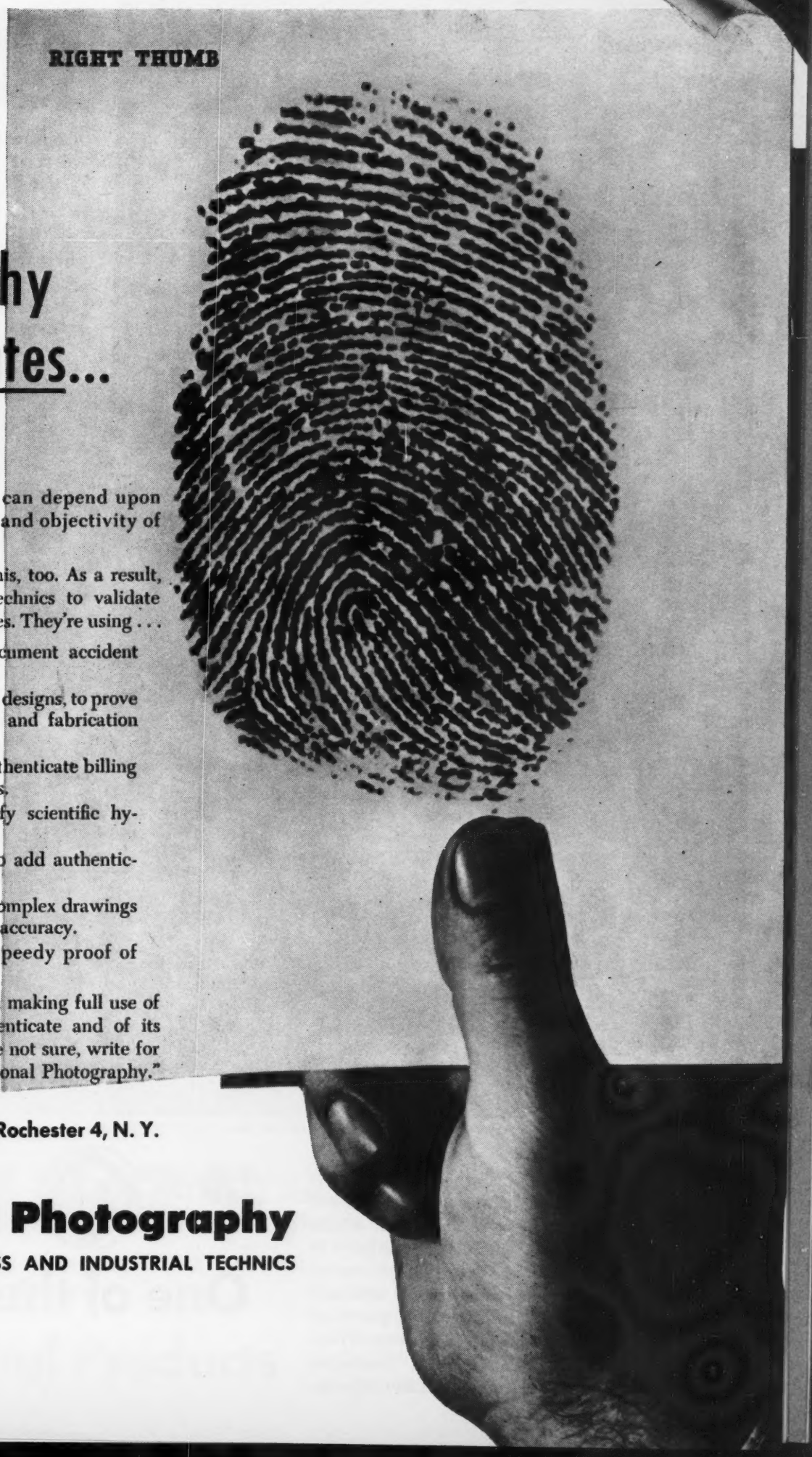

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Courts know this: that you can depend upon the accuracy, completeness, and objectivity of photography . . .

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Eastman Kodak Company, Rochester 4, N. Y.

Functional Photography

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NEVER OUT

One of this nation's greatest blessings is its vast resou of wood . . .

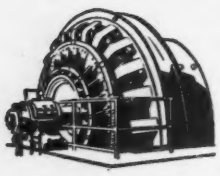
Look at this forest and look beyond!

You see . . . docks and ships, houses and airpla

You see . . . wood, plentiful and cheap . . . w used to make paper, sheer fabrics, sturdy new plas new lacquers, dyes and veneers.

You see . . . thousands of builders, craftsmen chemists building a new wonder world of wood.

You see . . . the hand of Allis-Chalmers mak



Whether your electric power requirements run to hydraulic or steam turbines . . . whether your needs are for generators, transformers, motors, control devices, or switchgear—expect from every Allis-Chalmers product advanced electrical engineering and design, thoroughly modern efficiencies. Specify Allis-Chalmers.

ALLIS-C

One of the Big 3 in Electri

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UT OF THE WOODS—AND GLAD OF IT!

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chines and equipment that help to expand the
hty wood industry—that enrich your life by bring-
the new world of wood closer to you!

* * *

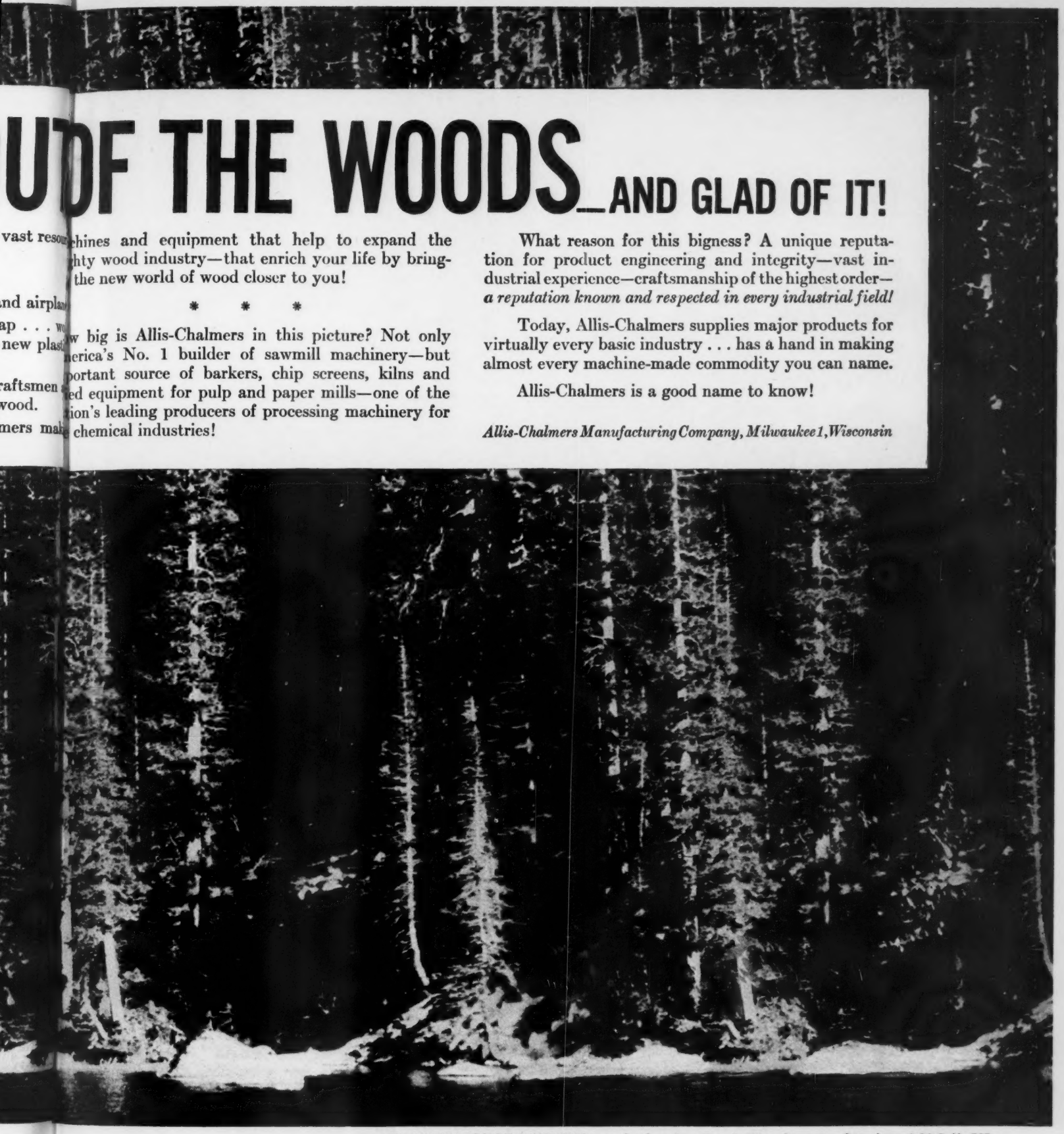
w big is Allis-Chalmers in this picture? Not only
erica's No. 1 builder of sawmill machinery—but
portant source of barkers, chip screens, kilns and
ed equipment for pulp and paper mills—one of the
ion's leading producers of processing machinery for
chemical industries!

What reason for this bigness? A unique reputation for product engineering and integrity—vast industrial experience—craftsmanship of the highest order—*a reputation known and respected in every industrial field!*

Today, Allis-Chalmers supplies major products for virtually every basic industry . . . has a hand in making almost every machine-made commodity you can name.

Allis-Chalmers is a good name to know!

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin



TUNE IN THE BOSTON SYMPHONY over the American Broadcasting Company, Saturdays, 9:30 P. M. EST

S-CHALMERS

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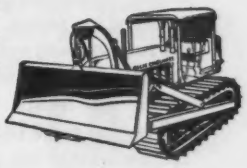


Allis-Chalmers builds tractors like this for the logging industry—mills for making flour—machines for mining and processing ores—pumps for moving almost any fluid—compressors and blowers—welders—speed changers—literally 1600 important industrial products. Call the Allis-Chalmers office in your city.

"He turned the heads of Congressmen"

The words are those of Rufus Choate, spoken in 1840. For in the rotunda of the Capitol at Washington, Clay, Calhoun and Webster were gazing in amazement at busts of themselves, turned by a copying lathe. Standing by was Thomas Blanchard, the inventor, holding a model of his machine. He was seeking a renewal of his patent, and Webster saw that the renewal was granted. To the ordinary surfacer then in use, Blanchard's lathe added the means of turning irregular forms, and since 1819 it had been proving its usefulness on gun-stocks, shoe-lasts and wheel-spokes.

Today all lathes, grinders, drills, boring mills, punches depend for their speed and accuracy upon anti-friction bearings. Many of these bearings are made by SKF . . . for over a long period of years SKF has applied its engineering skill to the development of ball and roller bearing units which meet almost every possible requirement of the machine tool industry.

With such long and diverse experience, an SKF representative is the best man to help you select

THE RIGHT BEARING FOR THE RIGHT PLACE

SKF INDUSTRIES, INC., PHILA., PA.

Another job for a coke oven!

SO THAT bad tooth has to come out. What's it got to do with a coke oven?

Listen to your dentist: "Nothing to worry about . . . we'll shoot a little novocain in there and you won't feel a thing."

Novocain. The wonderful drug that robs a tooth extraction of its terrors and its pain.

That's where the coke oven comes in. For coke ovens are responsible for toluene, which is used in the synthesis of novocain.

Modern Koppers coke ovens collect and preserve the priceless products of coke-making . . . the tar, the light oils, the gases that used to be wasted.

From these products American chemists and manufacturers today are making not only novocain, but hundreds of precious things vital to health, safety, and comfort.

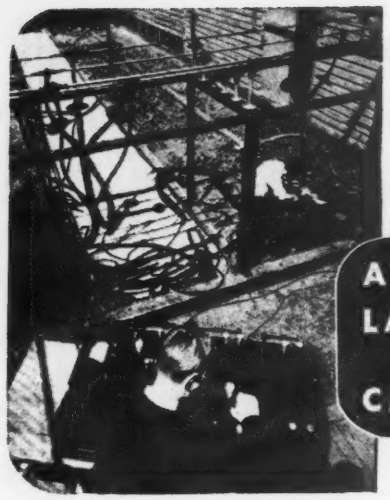
Koppers has designed and built the majority of all the coke ovens in America . . . as well as many of the processing plants which refine the numerous products that result from coke making.

Koppers does other important jobs, too. It treats millions of feet of timber every week with preservatives. It produces chemicals from coal. It makes piston rings, propellers, couplings, protected metal sheets, bituminous coatings, mothproofing preparations. It paves roads and streets with Tarmac. It manufactures roofing materials.

It is the application of these chemical and engineering skills to such a wide variety of fields that has made Koppers "the industry that serves all industry."

The industry that serves all industry

KOPPERS



Nothing is guessed at, nothing is taken for granted by the engineers in charge of Okonite's cable proving ground. Buried in various types of chemically different and highly corrosive earth, pulled into conduit or installed overhead, electrical cables are tested under controlled conditions of temperature, voltage and loading conditions duplicating those of actual operation.

In use since 1936, carefully-recorded tests made in this "outdoor laboratory" have disclosed valuable trends. As facts accumulate, Okonite engineers apply their findings to the improvement of their electrical wires and cables. The Okonite Company, Passaic, N. J.

OKONITE
insulated wires and cables
4389

AUTOMOTIVE CHEMICALS

(*Continued from page 32*)

of sugars will lower heat transfer and present a difficult cleaning problem.

Methanol gives the greatest freezing protection per gallon, ethylene glycol ranks second, and ethanol is the least effective. Antifreeze solutions do not solidify, but form slush at temperatures a little below their freezing points. Water freezes solid and expands nine per cent. As little as ten per cent antifreeze in water will prevent breakage from freezing down. In the normal mixtures methanol type antifreeze boils at about 190° F., ethanol type at 185° F., and ethylene glycol at about 220° F. Since the engine temperature may go up to 190° or more when the engine is shut off, caution must be taken in having the proper mixture. In summer all nonpermanent antifreeze solution should be drained out of the radiator, otherwise boiling will result. The boiling point of the concentrated antifreeze products (commercially 94 to 99½ per cent concentration) should not be confused with the boiling point of the water mixture which rarely exceeds 50 per cent concentration. Methanol is the cheapest and most effective antifreeze material although ethylene glycol is the more expensive but permanent antifreeze.

Most important are the physical and chemical properties which protect your car. The same is true of all cooling system chemicals. Price does not always indicate the quality of the product nor how economical it will be. Before you buy cooling system chemicals be sure that they will perform satisfactorily and will not damage any part of your automobile.

BROWN & SHARPE
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$\sqrt[7]{.031826} = ?$

Can You Solve it NOW?

Solutions involving logarithms need not be delayed because conventional log tables are not at hand. V-Pocket Log Table makes available eight-place logarithms in a handy vest-pocket size. No moving parts; large clear print on one piece washable plastic.

Table, directions and examples mailed postpaid upon receipt of one dollar.

TECHNICAL SERVICE (2)
P.O. Box 347, Niagara Falls, New York

MAYBE YOU NEED A PIANO LESSON

When you look inside a piano you see a harp-shaped metal plate on which the strings are strung. Even in a spinet it ordinarily weighs well over 100 pounds.

"Too heavy!" thought Winter & Company, who make pianos. (If you've ever moved a piano, you'll agree.) "Let's have Alcoa make an *aluminum* plate."

So, Winter's piano designers and Alcoa engineers put their combined experiences together to develop an aluminum plate. First, a strong aluminum alloy had to be found because the strings put an 18-ton pull on the plate. A special alloy was produced, *but* . . .

As the strings don't pull in the same direction or with the same force, in time the plate would creep, cause distortion, and the strings get out of tune.

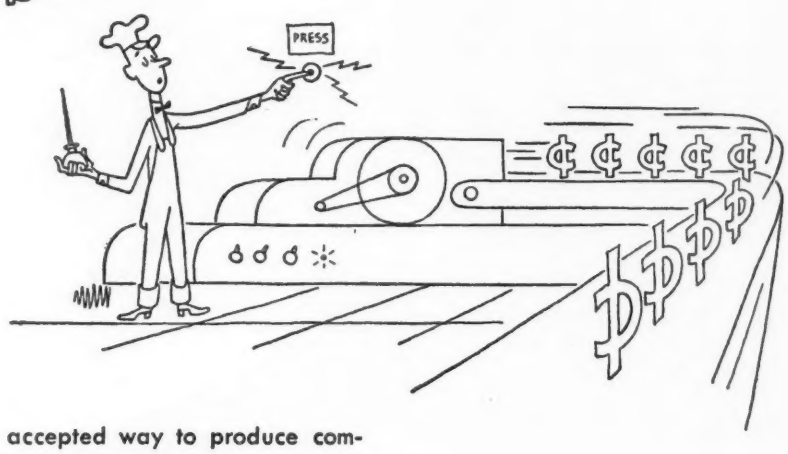
Alcoa engineers found a way to tell exactly where and how great the strains were . . . figured out how to balance the stresses and then stabilize the plate by an Alcoa-developed heat-treating process.

The result: The first successful aluminum piano plate, weighing only 45 pounds instead of 125, with tone quality enhanced.

That piano plate offers this lesson for young engineers to remember when they step from college into industry: Take a look at aluminum—with Alcoa engineers at your side—when you want strength with lightness in anything you are designing. Ideas click when men with imagination plus engineering—"Imagineering" as we like to call it at Alcoa—work with this versatile metal and with the greatest fund of aluminum knowledge in the world—Alcoa's. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pa.

ALCOA FIRST IN ALUMINUM

"Mass Precision" is Cheaper. . .



Slow, expensive methods are the accepted way to produce complicated, extremely accurate parts. Mass production methods are the accepted way to produce less complicated, less precise parts in volume at low cost. Can these two methods be combined for a cost advantage?

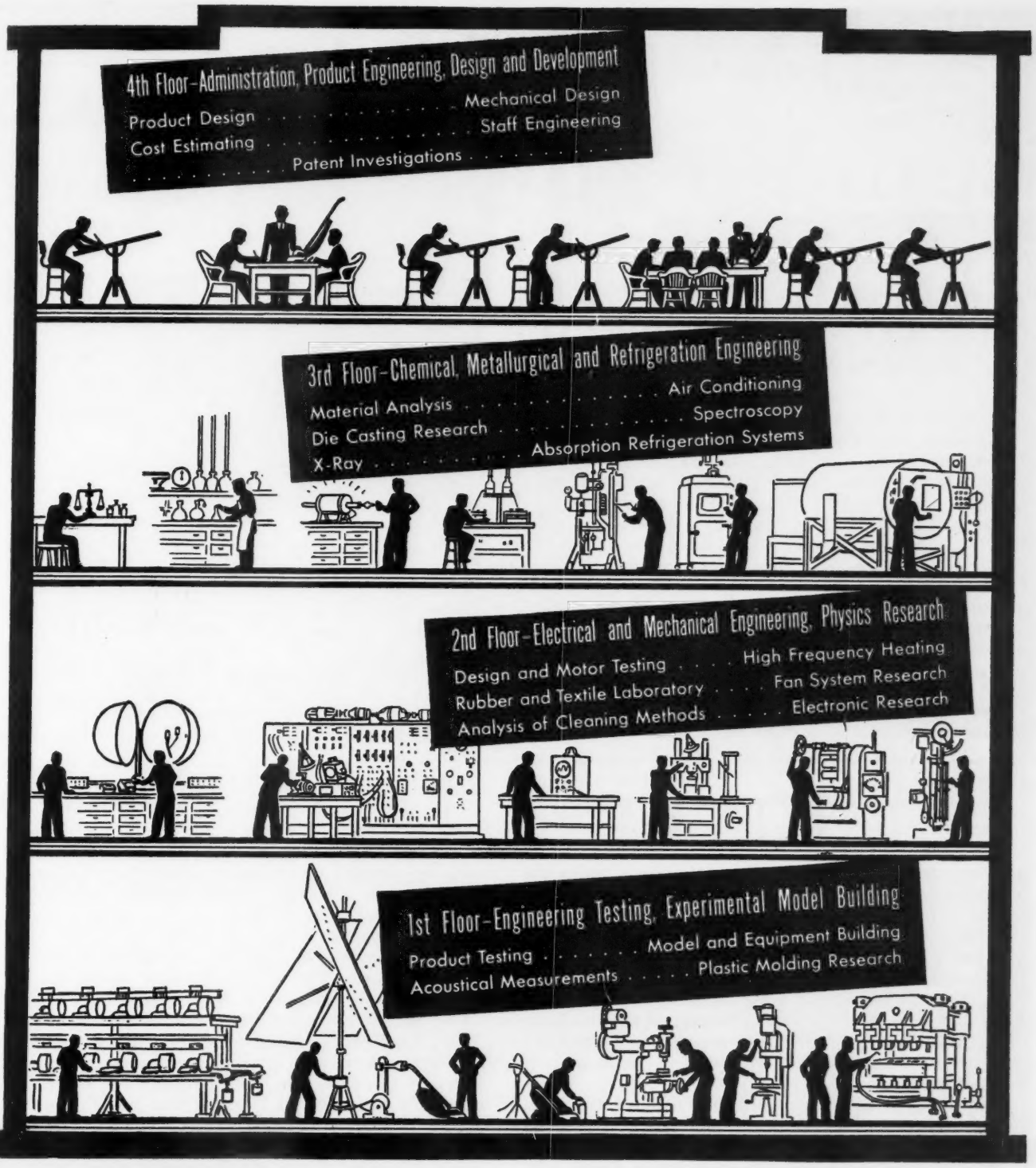
Yes! We, at Nichols, call this combination "Mass Precision." This is the means by which extremely complicated parts and assemblies can be mass produced with tolerances to "quarter-tenths" and surface finishes to "millionths", *on a strictly interchangeable basis.* Forty years of engineering research, modern machines in the hands of skilled workmen, and the finest gaging equipment are combined to make "Mass Precision" the faster, lower-cost way to solve difficult or "impossible" production problems.

Our new booklet "Mass Precision" shows what we've done for others . . . perhaps it will suggest what we can do for you. Write for your copy today.

W. H. NICHOLS COMPANY, 48 Woerd Ave., Waltham 54, Mass.

"Accurate" *Nichols*

PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS PRODUCTION



WHAT'S INSIDE HOOVER'S ENGINEERING DEPARTMENT?

There's more engineering to the job of staying in first place with any home appliance than meets the eye . . . so we've cross-sectioned the Hoover Engineering Department's modern 4-story building to show you.

It's "big-time" engineering.

More than 130 skilled people, a third of them graduate engineers, staff this Hoover "idea factory." We call it that because in doing a thorough job of planning and proving the Hoover Cleaner, Hoover engineers come up with developments, new ideas that find wide application in other industries—many of them far removed from the home appliance field.

THE HOOVER COMPANY

NORTH CANTON, OHIO

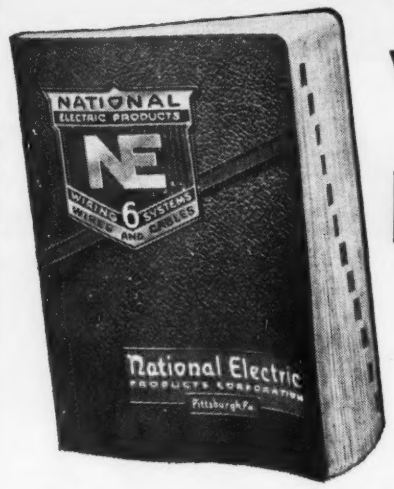
One-Man Ice-Making System Breaks Record!

The semi-automatic plant of the Polar Ice and Fuel Company, at Indianapolis, has completed a record run of over 550 days in which 42 tons of ice were made every day by ONE MAN. We believe no ice plant ever achieved such a volume of steady production before with only ONE MAN, working ONE SHIFT. This plant did it—and is still doing it—with Frick Refrigeration and Frick Ice-making Equipment.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, now in its 30th year, is approved under the G.I. Bill of Rights.

FRICK COMPANY, Waynesboro, Penna.

Attention ENGINEERS!



WRITE FOR NE's FREE ELECTRICAL DATA HANDBOOK

Here's a 350-page, 8" x 10" handbook that is invaluable to electrical engineers. It's an illustrated, products and parts catalog. Has handy reference tables, wire and cable terminology, formulas, specifications, electrical symbols for architectural planning, as well as wiring systems for industrial, commercial, and domestic requirements. Write for *your* copy.

National Electric
PRODUCTS CORPORATION
Box 897 — Pittsburgh 30, Pa.

NEW COMFORT ON THE RAILS

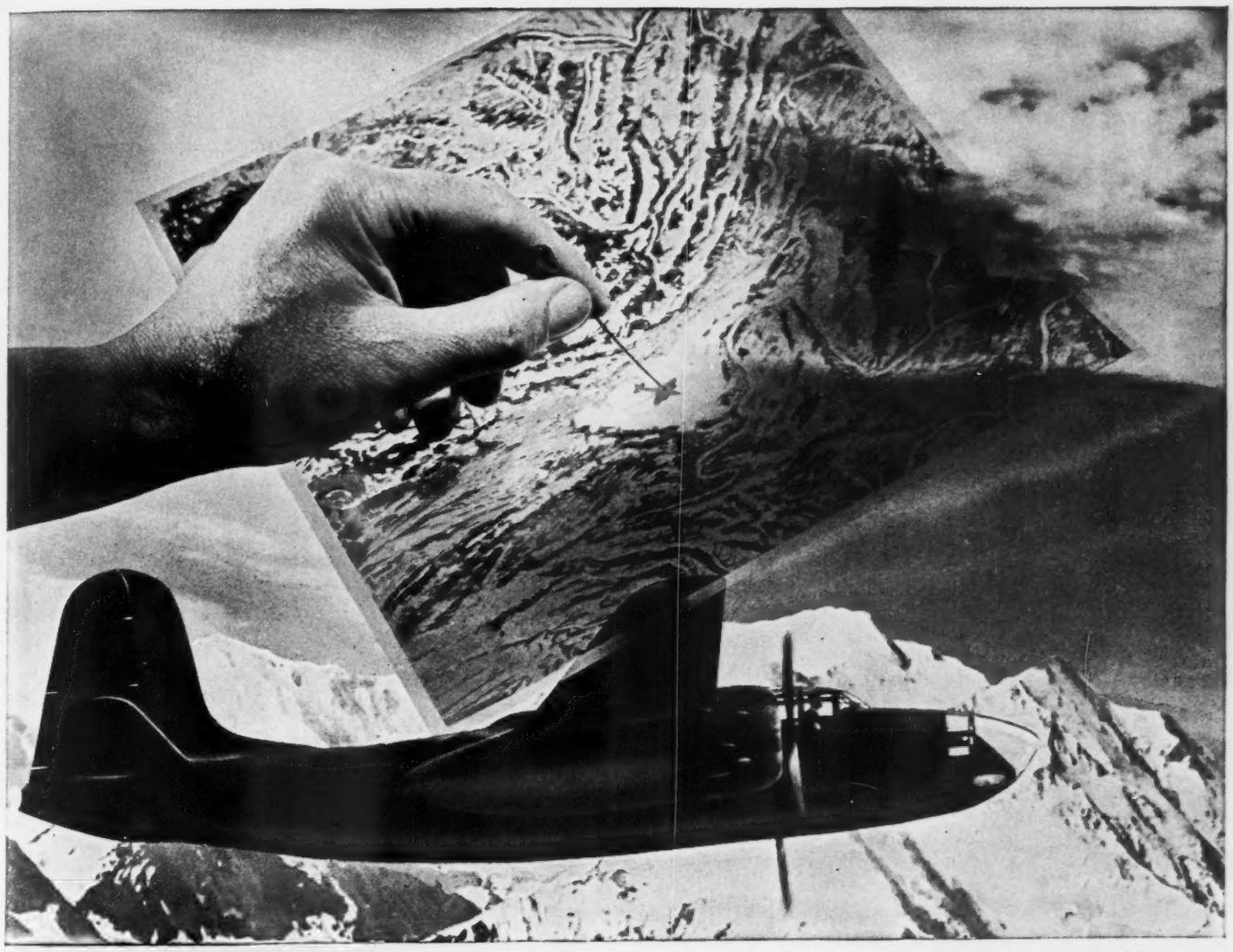
(*Continued from page 12*)

regular conveniences. In addition there is a moveable chair for daytime comfort. Finally, there is the drawing room, a large daytime room, with two moveable chairs, a three-person couch, two windows, and a separate, smaller room for the toilet and washing facilities. Sleeping three persons, the drawing room's beds appear in a variety of ways. A double tiered set of berths similar to the ones in the double bedroom and the compartment is made out of the three-person seat, while the third bed folds down out of the wall in the fashion of a Roomette bed.

Budd's version of the double bedroom comes in two different types. One has a three-person seat running crosswise, with beds similar to the Pullman accommodation of the same name; the other has a double seat running across the car, with an added moveable chair. The beds in the latter type of double bedroom come out of the wall to lie longitudinally along the car. Probably the most outstanding feature of these bedrooms is the lavatory cabinet, which, in addition to the regular toilet and washroom facilities, has complete shower equipment including a self-draining floor. When two of these neighboring double bedrooms — one of each type — are thrown together by again folding back the partition, they form the master bedroom which, according to Budd, is the most luxurious railroad accommodation yet — as can well be imagined with its two windows, three different kinds of seats, two lavatory cabinets, and four beds!

In addition to this large variety of passenger accommodations, the Pullman Company is proposing to build several new and unique cars for other purposes. Conceived as supplements to present diners, the Grillroom and Cafeteria cars are modern, self-service cars to be used on crowded trains where efficiency is essential in serving meals. Seating fifty-six persons, the Cafeteria car has a kitchen in the center, accessible through self-service counters at both ends. Seating accommodations are at both ends of the kitchen, the seats being arranged along the wall. The Grillroom car is much the same except that the seats are arranged in groups, breaking up the monotony of the usual rows of tables and chairs. New dining cars themselves will offer increased service to patrons because of a revolutionary seating pattern. In use in the Grillroom and Cafeteria cars as well as in these new diners, the principle of diagonal seating promises to do away with many of the accidents which happen in present-day diners. Because of this arrangement of seating all persons diagonally, every passenger can enjoy more personal comfort, besides being able to sit down or get up without disturbing anyone else. Aisles will be clearer since waiters may step between tables and serve from the side. On the whole, eating will become less of a task and more of an enjoyment on the new diagonal diners.

In addition to these new kinds of diners, Pullman intends to offer other kinds of luxury cars. The Casino car contains private daytime rooms — with individual radios — which can be used for games, or for more serious activities such as business conferences. Adjoining rooms can be combined to form a room big enough for a six-handed card game, complete with two couches for kibitzers. Venetian blinds and full length drapes will add to the feeling of comfort and convenience that these rooms will present. (*Continued on page 50*)



Developed by RCA as an aid to blind bombing in wartime, Shoran is a new radar yardstick for world mapping

SHORAN—a surveying system with pin-point accuracy!

One small error in a map can be costly in the location of an oil well or mining property. But with Shoran, vast areas can now be charted by plane with an error of less than twelve inches in five miles—and in a matter of minutes or hours as opposed to weeks or months that would be required by laborious surveys made on the ground. Shoran is called one of the most important geographic inventions since the compass.

Shoran can also direct a plane flying in a blackout or heavy overcast with such accuracy that during the war it was possible to drop bombs only a few hundred feet ahead of completely invisible advancing troops below with unerring precision.

Just as Shoran is a revolutionary stride forward in map-making, so do all RCA products represent the farthest point of progress in their fields.

And when you buy anything made by RCA or RCA Victor, you are sure of getting one of the finest instruments of its kind science has achieved.

Radio Corporation of America, RCA Building, Radio City, New York 20. Listen to The RCA Victor Show, Sundays, 2:00 P. M., Eastern Standard Time, over NBC Network.

Until recently a closely guarded military secret, Shoran was developed at RCA Laboratories—a world center of radio and electronic research. Here, in this vast community of scientists, the same imagination and skills that developed Shoran keep RCA and RCA Victor the outstanding names in radio, television and recorded entertainment.

RCA **RADIO CORPORATION of AMERICA**

Working in a Dow physical research laboratory, this young man is operating a machine to test plastic materials.

Plastics—a growing field for the young technician

Interest in the use of plastics grows apace. Products in great variety for the revived consumer's market show their influence —their special utilitarian value—their ready adaptability to ideas in design—their distinctive beauty.

Plastic materials are custom made in the laboratory for modern living. Dow chemists have developed many new plastics among which is Styron, a material that rose to a leading place during the war years. It is a remarkable combination of brilliant beauty and properties of a strictly utilitarian nature. Today, Styron is in demand for products that range from toys and costume jewelry to batteries and automobile parts. Many top-rate refrigerator makers use it in ice compartment doors, shelves and other parts.

Other Dow plastics are: Saran for colorful fabrics that can be cleaned with a damp cloth, non-rusting window screen or corrosion-resistant pipe and tubing; Saran Film and Ethocel Sheeting for better packaging; and Ethocel for durable molded products.

Development, testing and production of these plastic materials are carried on by technical men with special training. It is a great and growing field for young men who can turn their college training in this direction.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit
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Industry Relies on COLUMBIA for Essential Chemicals

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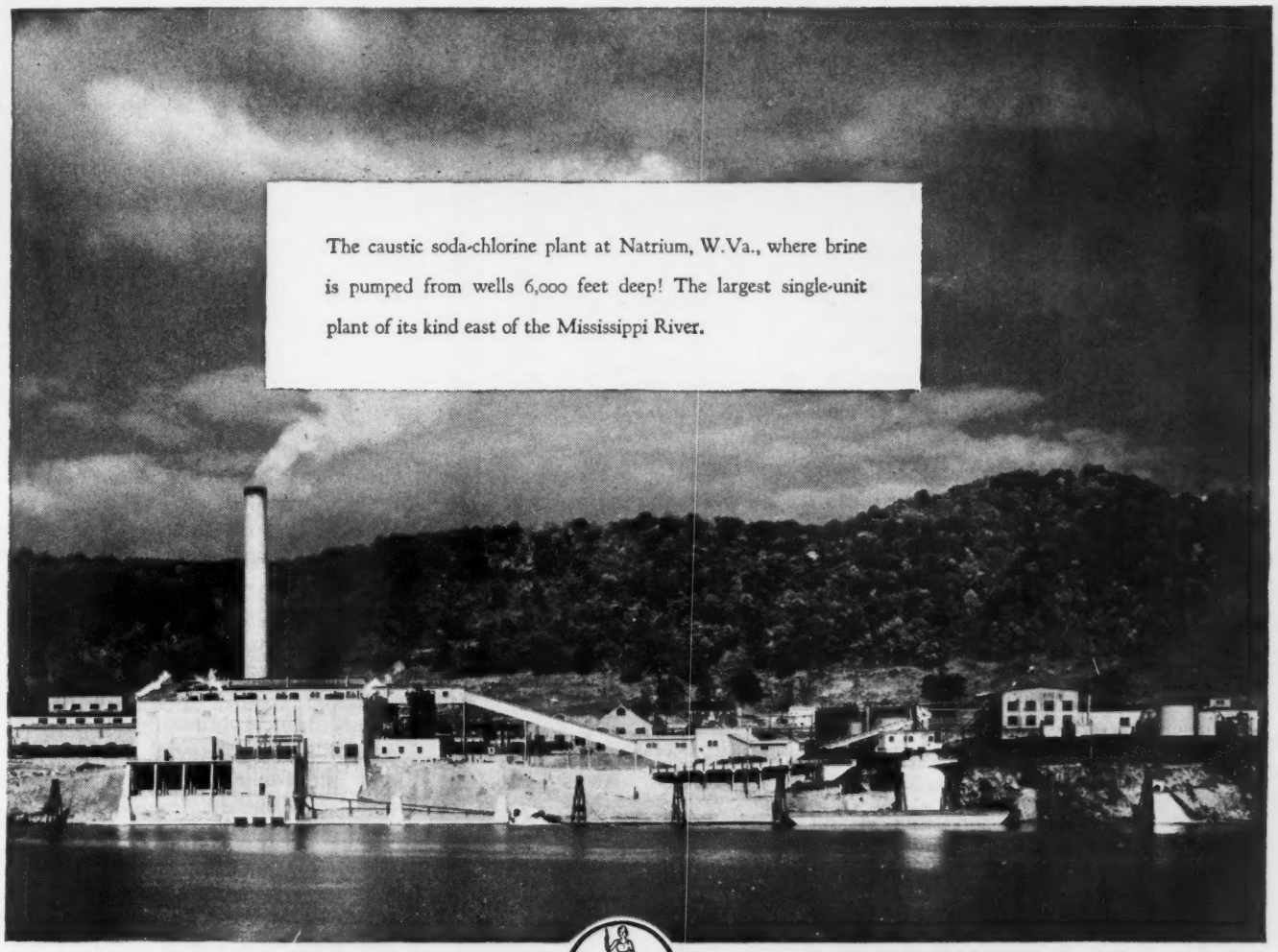
CAUSTIC SODA
LIQUID CHLORINE
CALCIUM CHLORIDE
SODIUM BICARBONATE
MODIFIED SODAS
CAUSTIC ASH
PHOSFLAKE (*bottle washer*)
SODA BRIQUETTES (*iron desulphurizer*)
CALCENE T (*precipitated calcium carbonate*)
SILENE EF (*hydrated calcium silicate*)
PITTCHLOR (*calcium hypochlorite*)

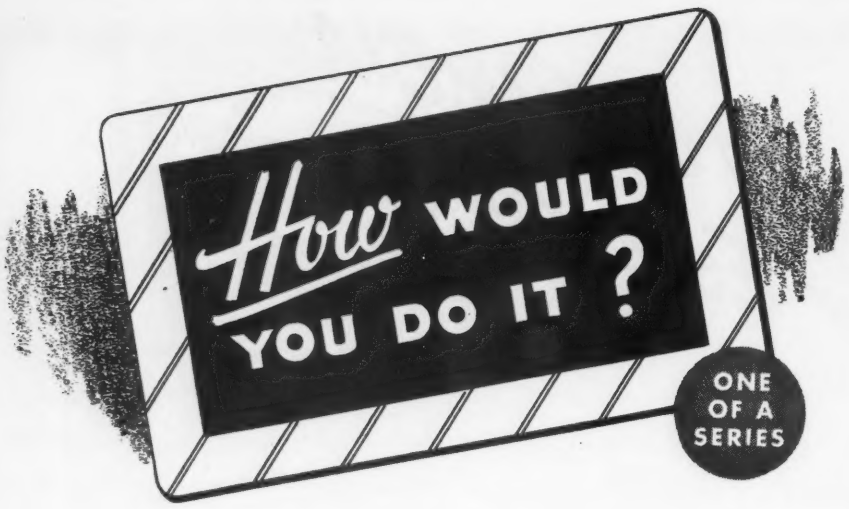
The huge caustic soda-chlorine plant, shown below, was built and operated by Columbia for the Defense Plant Corporation. Columbia has now purchased it in order to bring this important source of chlorine and caustic soda into the cross-the-nation group of strategically located plants from which Columbia customers are served. Thus "Natrium" becomes a major factor in serving peacetime industry just as it was in producing gigantic quantities of chemicals for war.



The caustic soda-chlorine plant at Natrium, W.Va., where brine is pumped from wells 6,000 feet deep! The largest single-unit plant of its kind east of the Mississippi River.

COLUMBIA CHEMICALS

PITTSBURGH PLATE GLASS COMPANY • COLUMBIA CHEMICAL DIVISION
FIFTH AVENUE at BELLEFIELD, PITTSBURGH 13, PENNSYLVANIA
Chicago • Boston • St. Louis • Pittsburgh • New York • Cincinnati • Cleveland • Philadelphia • Minneapolis • Charlotte • San Francisco



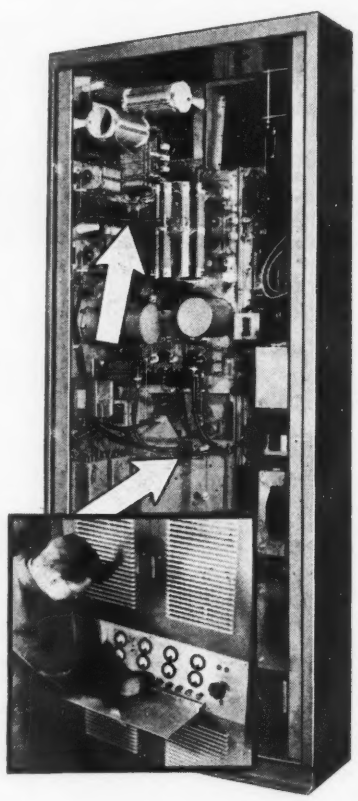
PROBLEM— You're designing a radio broadcast transmitter. The circuit includes condensers and other variable elements which must be adjusted by the operator. You want to place these elements for optimum circuit efficiency and where they will be easy to assemble, wire, and service. At the same time, you want to centralize the control knobs at a point convenient to the operator. How would you do it?

THE SIMPLE ANSWER

Use S.S.White remote control type flexible shafts to couple the variable elements to their control knobs. This leaves you free to place both the elements and the knobs anywhere you want them. And you get control that is as smooth and sensitive as a direct connection because S.S.White remote control flexible shafts are engineered expressly for this kind of service.

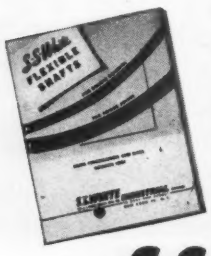
★ ★ ★

This is just one of hundreds of remote control and power drive problems to which S.S.White flexible shafts provide a simple answer. That's why every engineer should be familiar with the range and scope of these "Metal Muscles" for mechanical bodies.



Here's how one big radio manufacturer did it.

WRITE FOR BULLETIN 4501



It gives essential facts and engineering data about flexible shafts and their application. A copy is yours for the asking. Write today.

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MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

NEW COMFORT ON THE RAILS

(*Continued from page 46*)

The Junior Club Car section — intended for use on the same Casino car described above — will occupy one end of the car, providing children a place to frolic under the watchful eye of trained stewardesses and allowing parents to relax and enjoy their trip. Some of the amusements provided for the tots are a slide — reached through a cave with a concealed stairway — a marionette show, a miniature piano, various kinds of sofas, a writing desk, a blackboard, and an assortment of books, games, and toys. Designed to be attractive to the children, this seemingly fantastic idea could have very practical results since it would mean a more enjoyable trip for all passengers concerned.

Finally, Pullman has announced plans for what is perhaps the epitome of all travel comfort accommodations. The Club-Cinema car, which can be used as a bar-lounge during the day and transformed into a night-club and movie theater at night, offers the last word in rail entertainment. The chairs in the club half of the car can fold into the wall, leaving space for dancing, while the seats in the lounge section can be rearranged from their daytime positions along the walls into rows for showing movies at night.

With further plans under way for such things as Living Room cars to replace the present Parlor cars — the new cars would have new, more comfortable seats, somewhat along the line of the seats in the Day-Nite coach, arranged in cozy little groups of one to five, to eliminate the barrenness of straight-line set-ups — and convertible coach-lounges — rooms in the middle of coaches which would serve as social lounges by day and dressing rooms by night, one each for men and women — there seems to be no limit to the proposed comfort on the rails. Truly, to the average passenger, the railroads are becoming really homelike places for living while on the move instead of simply barren means of conveyance. And to the gadget-minded engineer, the roads are becoming true extravaganzas of carefully designed and useful contraptions.

HOSPITAL - Side Elevation, Cut-away View

OXYGEN TO BREATHE is the most important thing in the world to one who is ill and unable to get enough for life from the air alone.

The use of oxygen in medical practice has grown rapidly in recent years. Physicians have found it effective in the treatment of certain types of heart disease, shock due to wounds or injuries, following major operations, and for numerous other illnesses.

The need for extra oxygen is so frequent in hospitals that many of them, instead of depending on cylinders of oxygen brought to the bedside, now have convenient oxygen outlets in many rooms and wards. Oxygen is brought directly to the bedside through an unseen "pipeline" from a centrally located "bank" of oxygen cylinders.

Oxygen is a principal product of Units of UNION CARBIDE. It is supplied to hospitals—and in much greater amounts to industry for numerous mass-production operations—largely through The Linde Air Products Company.

Linde Oxygen is now so readily available that no one need ever be without oxygen for any purpose. Oxygen is but one of the many basic and essential products from UCC—materials which, all together, require continuing research and engineering work with over a third of the earth's known elements.

FREE: *Physicians, nurses, teachers, and others who would like more information on the availability of oxygen, and on the various types of oxygen therapy equipment, are invited to write for a copy of the* "OXYGEN THERAPY HANDBOOK." *Ask for Booklet P-10.*

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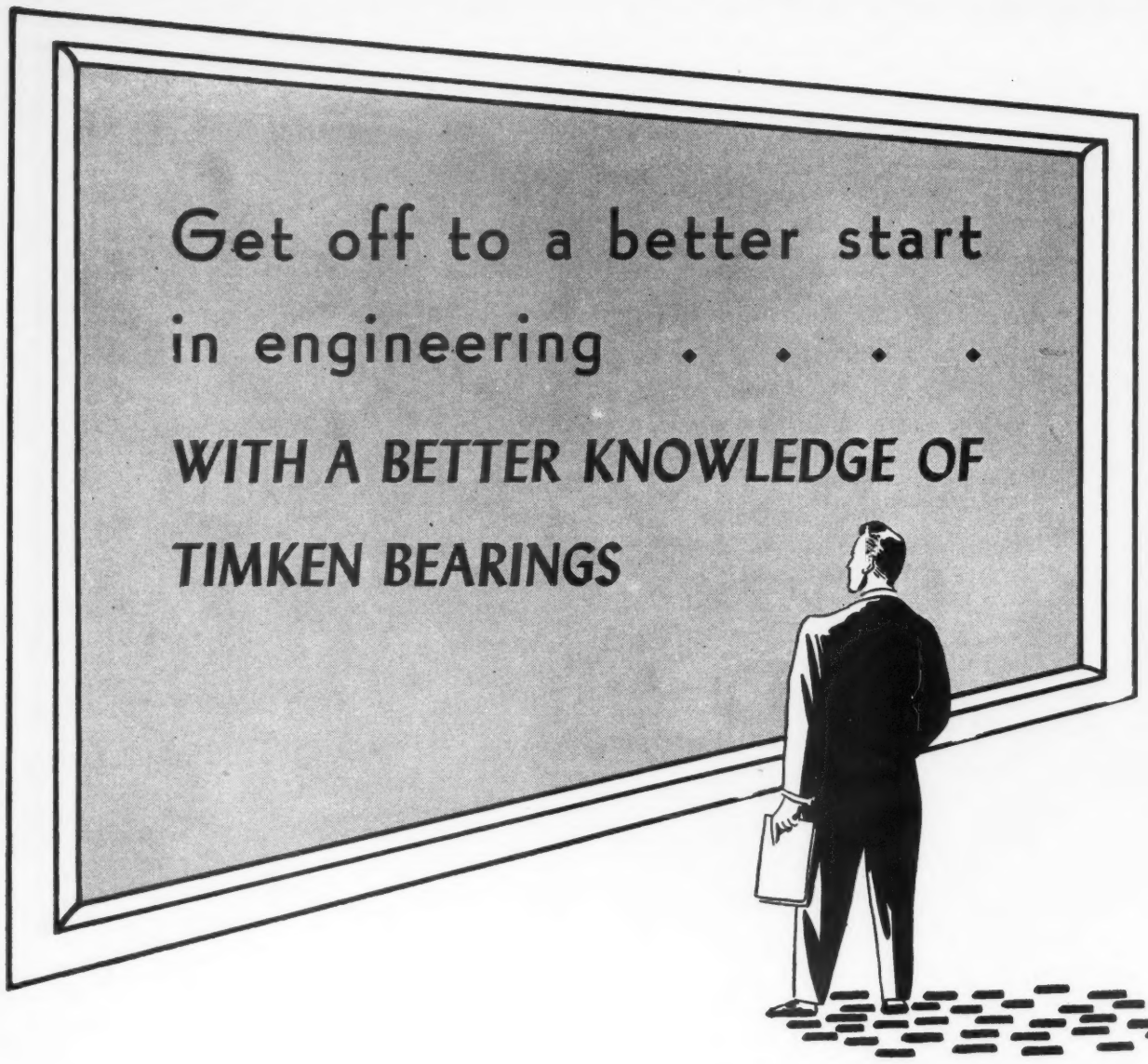
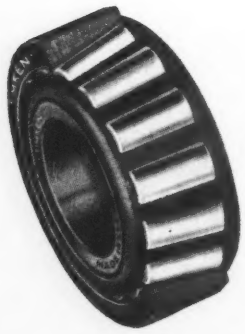


A good start is half the race. The more you know when you graduate, the better your opportunity for success.

Your professors have your best interests at heart, but what you learn outside the classroom will be a plus advantage of great value when you toe the mark for the start of your career.

Take bearings for example. No form of mechanical equipment with rotating parts can operate without them. By acquiring now a thorough knowledge of Timken Tapered Roller Bearings—their design, application and possibilities—you will be in position to meet and beat any bearing problem you ever may encounter.



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For Timken Bearings have proved their ability to serve in machinery throughout all industries and have received the universal acceptance and preference of engineers everywhere. They are the bearings experienced engineers specify more than any others.

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66⅔% WITH GAS

Mr. C. D. Pruden, Vice-President and Manager, points out several additional advantages of GAS-fired ovens:

—unexcelled uniformity of product

—increased production through rapid baking

—cleanliness of core-rooms

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MORE AND MORE...

THE TREND IS TO GAS

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Photo by Despatch Oven Company, Minneapolis, Minnesota

Conversion to core-ovens fired by natural gas has proved to be a profitable investment for the South Park Foundry and Manufacturing Company, South St. Paul, Minnesota. GAS-firing reduced fuel costs by two-thirds.

Conversion to Gas is a consistent trend in industrial and process applications because of these important, inherent features of GAS:

- **DEPENDABILITY**
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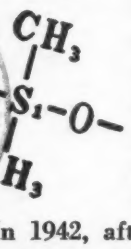
. . . a great name in research with a big future in CHEMISTRY

SILICONE CHEMISTRY

The Opening of a New Frontier

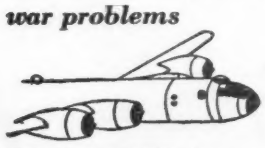
Organosilicon chemistry has gone to work. A little-known and sparsely investigated field for 40 years, organosilicon chemistry now offers tremendous opportunities for exploration. The silicones, but one corner of this field, have already proved themselves in the years of war.



In 1942, after four years of intensive research, General Electric built a pilot plant for the production of a number of silicone products. Based on new chemical reactions, this plant operated under wartime secrecy to produce silicones for jobs no other materials could do.

There is new mastery over heat, cold, and moisture in the man-made silicone molecule. Its tough backbone of silicon and oxygen gives stability and endurance. Its carbon and hydrogen lend versatility and variety to the numerous new kinds of molecules. Silicones are something new under the sun.

G-E Silicone Rubber solves war problems



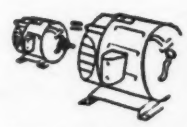
G-E Silicone Rubber stays rubbery from 575° F. to 60° below zero—a temperature range that natural and synthetic rubbers can't stand. Gaskets made of G-E Silicone Rubber were used to advantage in turbosuperchargers . . . naval searchlights and signal equipment . . . chemical manufacturing processes . . . electrical equipment. Silicone rubber needs only tensile strength to make heat-defying tires that might outlast your car.

Silicones put water in its place

DRI-FILM is the patented name for a number of G-E Silicone water repellents that vary according to their application to ceramics, plastics, textiles, and other materials. A coating of transparent DRI-FILM, invisible with a microscope, is durable enough to shed water for years at a time. DRI-FILM was used to treat paper gas mask filters . . . naval binoculars . . . tank periscopes. Some foreseeable DRI-FILM possibilities are: treatment for bathroom tile and porcelain . . . better electron tube performance in vest pocket radios and hearing aids . . . showerproof clothing that looks and feels like ordinary clothing . . . drier trout dry flies . . . paper plates for serving hot food.

Closer to the ideal insulation

G-E Silicone Resin Varnishes, used with glass fiber approach the long-sought-for ideal insulation. It's



now possible to design a given power rating into electrical apparatus with less insulation—and save up to 40 per cent in its weight and bulk. Think what such savings in weight and bulk will mean in future electrical apparatus!

Lubrication comes from sand

Silicone oils offer previously unheard-of viscosity constancy over a wide temperature range . . . they are chemically inert . . . they can be made rust-inhibitive . . . they won't sludge. Silicone oils promise to bring more compact, trouble-free hydraulic systems and pumps which will be sealed permanently by the manufacturer.

The Chemical Department of General Electric—a great new name in chemistry—is turning up more new and amazing silicone possibilities every day. A new G-E plant for commercial silicone production now is being built at Waterford, New York. Soon, many tested G-E Silicone products will be available to industry. For Silicone information, write to the Chemical Department, General Electric Company, 1 Plastics Avenue, Pittsfield, Mass.

A message to students of chemistry and chemical engineering from

DR. IRVING LANGMUIR

Associate Director, G-E Research Laboratory, Winner of Nobel Prize in Chemistry

There will always be new frontiers of science. Opening up right now at General Electric is the broad frontier of organosilicon chemistry. Scientific research and product development in this fascinating field challenge the young chemist. And the building of a whole new chemical industry offers splendid opportunities to the ambitious chemical engineer.

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